POLAR
PAM
4170

POLARPAM

Operating the trans Alaska pipeline

Alyeska pipeline
SERVICE COMPANY

Pam: 621.644:(*40) APSC

Contents

General 2
Pump Stations 4
The Pipeline 8
Terminal 10
Operations 15
History/Future 20

(Cover) The pipeline passes Wiehl (left) and Sukakpak mountains south of Atigun Pass in the Brooks Range.

(1) Pump Station 1 at Prudhoe Bay is the pipeline's starting point.

(2) The line stretches more than 100 miles across the desolate North Slope.

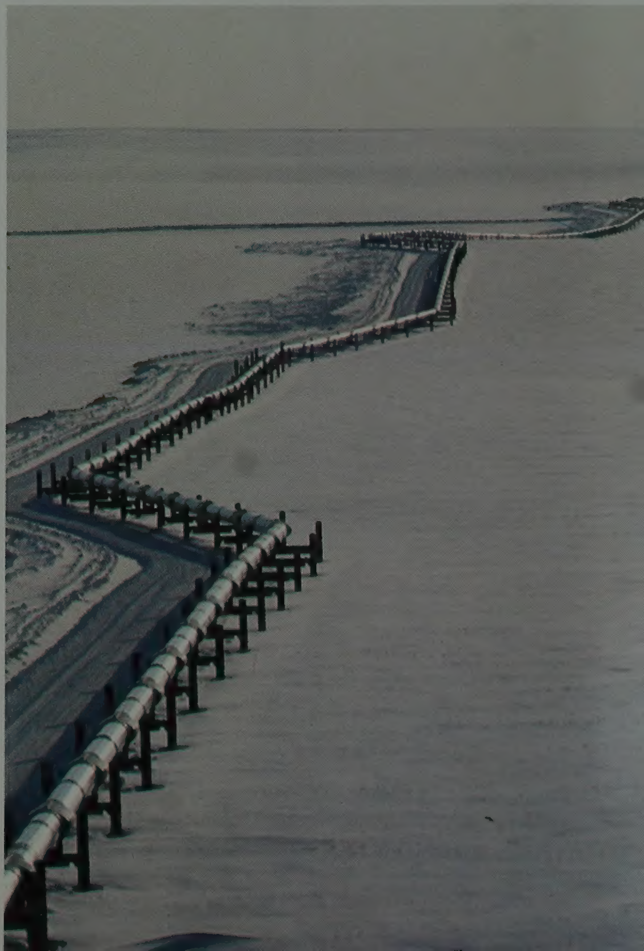
(3) Within close proximity are several key pipeline elements: pump station, microwave tower, above-ground pipe with heat pipes, and transition to buried pipe.

(4) Among the pipeline's safety systems is this firefighting foam-maker equipment at the Valdez Terminal.

(5) The trans Alaska oil delivery system ends at the Valdez Terminal tanker berths.

(1)

(2)



The pipeline industry is not new; hundreds of pipelines have been built the world over, and have attracted little attention. But because of the age in which it was built and the land across which it passes, the trans Alaska pipeline is unique. And its construction attracted no small measure of attention, from the government and public as well as special interest groups.

The severe climate and rugged terrain which characterize the pipeline route tested the industry's ability to adapt, to expand present technologies to allow for contingencies never before necessary in this country. Design solutions were developed for such construction obstacles as lack of existing means of communications and transportation; unstable permafrost soils; near-vertical slopes; some 800 river and stream crossings. Allowances had to be made for wildlife migration routes, spawning grounds and natural habitats to be left undisturbed.

The industry met those challenges — successfully. The job was finished on schedule, and at the time of its completion bore the distinction of being the largest privately financed construction project ever undertaken.

But now the construction, its problems and distinctions are history. When the first Prudhoe Bay crude oil entered the line in the summer of 1977, it marked the transition from construction to operations. It is the purpose of this publication to provide some measure of understanding of the magnitude and complexities of safe, responsible operation of this historic line.

BOREAL INSTITUTE
LIBRARY

Rec'd: Mar 20, 1979
Order No.:
Price: free
Acc. No.: 33933

(5)

General

The 800-mile-long trans Alaska pipeline carries crude oil south across Alaska from Prudhoe Bay on the North Slope to Port Valdez on Prince William Sound. It transports oil from the recoverable reserves of approximately 9.6 billion barrels which are located in the Prudhoe oil field.

The pipeline and related facilities occupy 12 square miles of Alaska's 586,400 square miles. Along its route, the line crosses plains, three rugged mountain ranges, and several large rivers. It stretches from a cold, desert Arctic environment....through Interior Alaska and its seasonal temperature extremes....to a coastal destination with high precipitation.

Careful analysis of eight proposed routes led to selection of the path. Those earlier studies, as well as the design and construction of the pipeline, were faced with the complications of climate, terrain and government regulations.

At the Prudhoe Bay field, oil flows from wells, via a gathering system, to the point at which Alyeska Pipeline Service Company's responsibility starts: Pump Station 1. From there, the oil begins its southerly movement up the gradual incline of the North Slope. For more than 100 miles, the line crosses rolling, treeless tundra, all underlain by permafrost, as is much of the rest of the route.

The line then ascends the Brooks Range, where, at Atigun Pass, it reaches its highest point: 4,800 feet above sea level. An immediate and long descent takes the pipeline into the spruce, birch and aspen forests of Alaska's northern Interior and into the rolling hills north of the Yukon River. One hundred miles after crossing that historic river, the line passes near Fairbanks. It then climbs over the second of three mountain ranges, reaching 3,500 feet above sea level in the Alaska Range. Descending and climbing once again to 2,800 feet, the route traverses the Chugach Range before dropping to sea level at Valdez. The marine terminal at the Southcentral Alaska port community is on an ice-free arm of Prince William Sound, which, in turn, opens onto the Gulf of Alaska and the North Pacific.

The pipeline is 48 inches in diameter. More than half the pipeline is elevated and the remainder is buried below ground. Elevated sections range from about 30 miles to a few hundred feet in length.

In addition to the pipeline itself, principal system components are pump stations which push the oil along its course, and the Valdez Terminal with its oil storage and tanker loading facilities.

The line's initial operating capacity is 1.16 million barrels of oil a day. Eight pump stations are required for this level. At any time, the operating pipeline contains 9 million barrels of oil.

At full design capacity, the pumping rate would be 2 million barrels a day. To reach that capacity would require additional equipment at present pump stations, completion of four additional stations and, possibly, additional storage and tanker facilities at Valdez.

Responsibility for the system's operation, as well as for its earlier design and construction, lies with the Alyeska Pipeline Service Company. Alyeska is owned by eight firms: Amerada

Profile of Pipeline Route

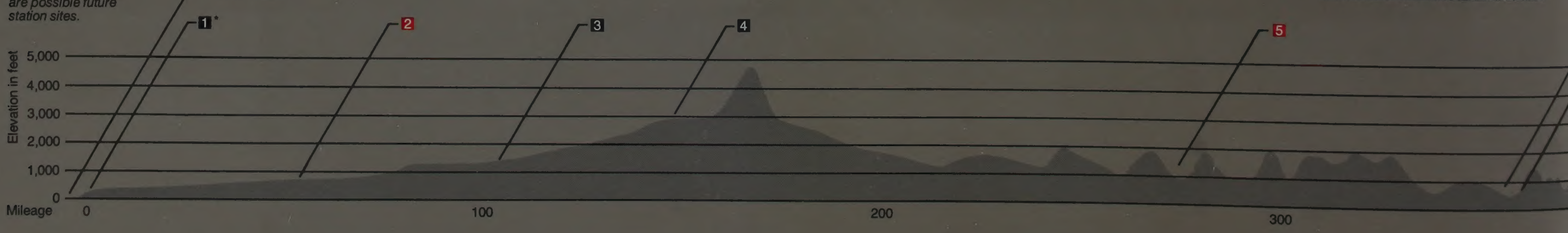
Source of the oil is the Prudhoe Bay field on the North Slope.

More than half the 800-mile pipeline is elevated.

Longest of 800 river and stream crossings is over the Yukon River.

*Boxed numbers are pump stations.

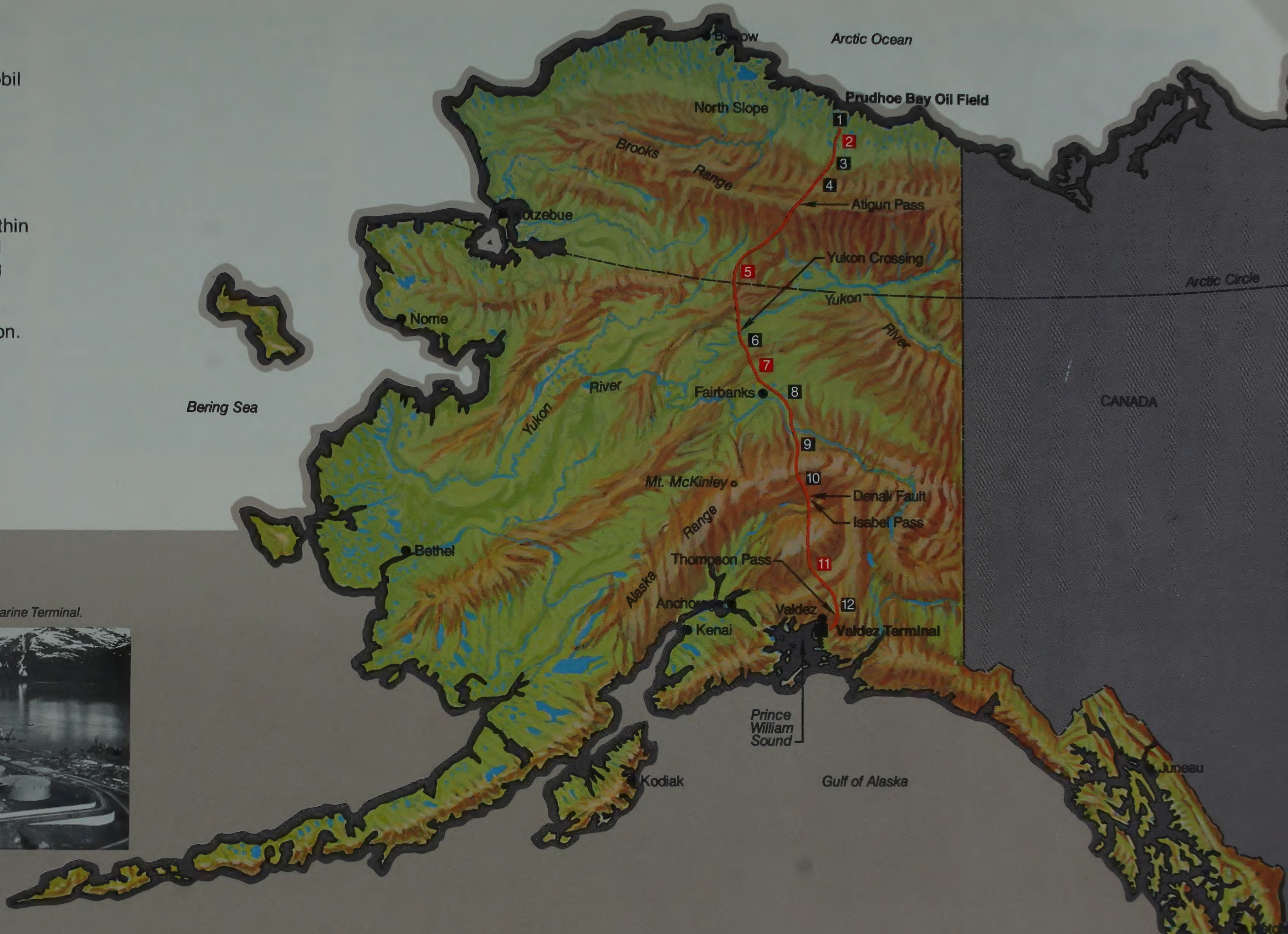
Numbers in red are possible future station sites.

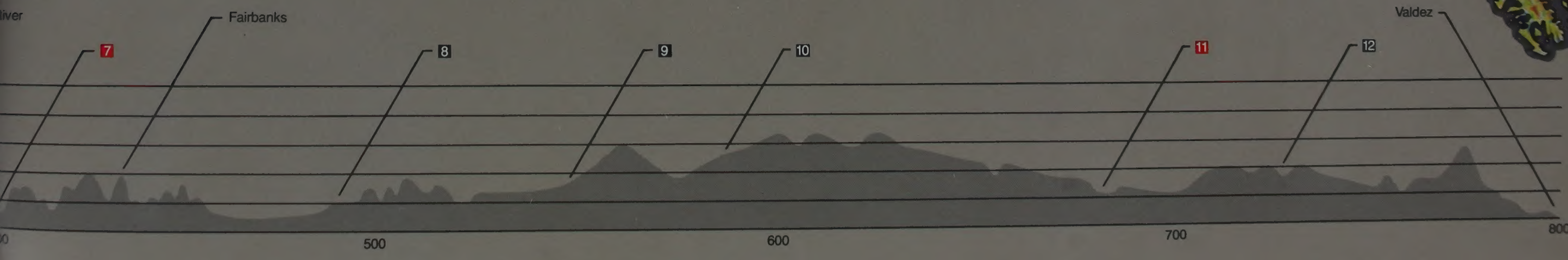


Hess Pipeline Corporation, ARCO Pipe Line Company, SOHIO Pipe Line Company, Exxon Pipeline Company, Mobil Alaska Pipeline Company, Phillips Alaska Pipeline Corporation, Union Alaska Pipeline Company and BP Pipelines Inc.

The pipeline is a common carrier, and, therefore, lies within jurisdiction of several Federal and State agencies, including the National Transportation Safety Board and the Federal Energy Regulatory Commission.

Southern terminus of the line is the Valdez Marine Terminal.





Pump Stations

Crude oil is moved down the pipeline by a series of pump stations. With the existing eight stations in full operation, the line's capacity is 1.16 million barrels a day. Completion of four other stations would increase the line's capacity to 2 million barrels a day.

Seven of the eight operating stations have three mainline pumps, two in operation and one on standby. Station 8 has two two-stage pumps arranged so that one pump functions as two. At the 2 million barrel level, all 12 stations would have four pumps, three operating and one on standby.

The stations were built specifically for Arctic conditions. All equipment and virtually all station piping are in insulated, windowless buildings connected by enclosed hallways. Stations are designed to withstand temperatures down to minus 60 degrees Fahrenheit and winds up to 100 miles per hour.

Each station supplies all of the life support requirements of station personnel. Included at each station are sleeping quarters, kitchen, recreation area, dining room, and laundry, toilet and shower facilities. Support systems include heating, power generation, water supply purification and storage facilities, sewage and waste disposal, safety apparel, fire detection and extinguishing systems and portable fire suppression equipment.

In addition to the living quarters building, pump stations include a control building, main pump building, booster pump building, shop and warehouse building, flammable liquids building, pressure relief tanks to be used in the event of an emergency shutdown, turbine fuel tanks and gasoline storage tanks, pump island, heliport facilities and water tank. Also included are tank dikes, drainage, and access roads. Each station is fenced around its perimeter.

The shop and warehouse building includes space for the garage, raw water treatment system, sewage treatment plant, waste oil disposal system, lifeline generator system, air compressor, heaters and storage.

The four-room control building houses station control panels, emergency batteries, communications systems and electrical power generation equipment.

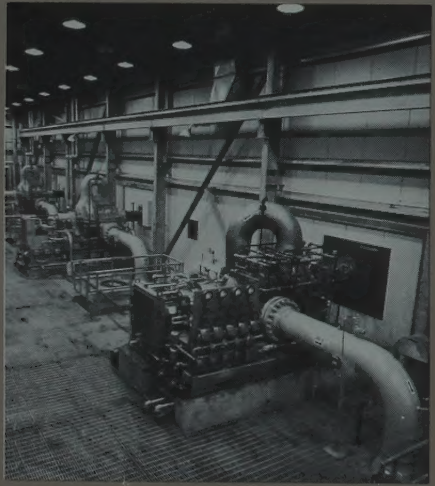
In the booster pump building are booster pumps employed to increase pressure to mainline pumps at Station 1, and to transfer crude oil from pressure relief tanks to the pipeline at other stations.

Located within the main pump building—a two-room, two-level structure—are gas turbine-driven mainline pumps. The turbines and mainline pumps are on the upper level. Piping and valves are on the lower level. The building has an overhead bridge crane for equipment handling and maintenance.

Each mainline pump can move 19,687 gallons of oil a minute, which is 675,000 barrels a day.

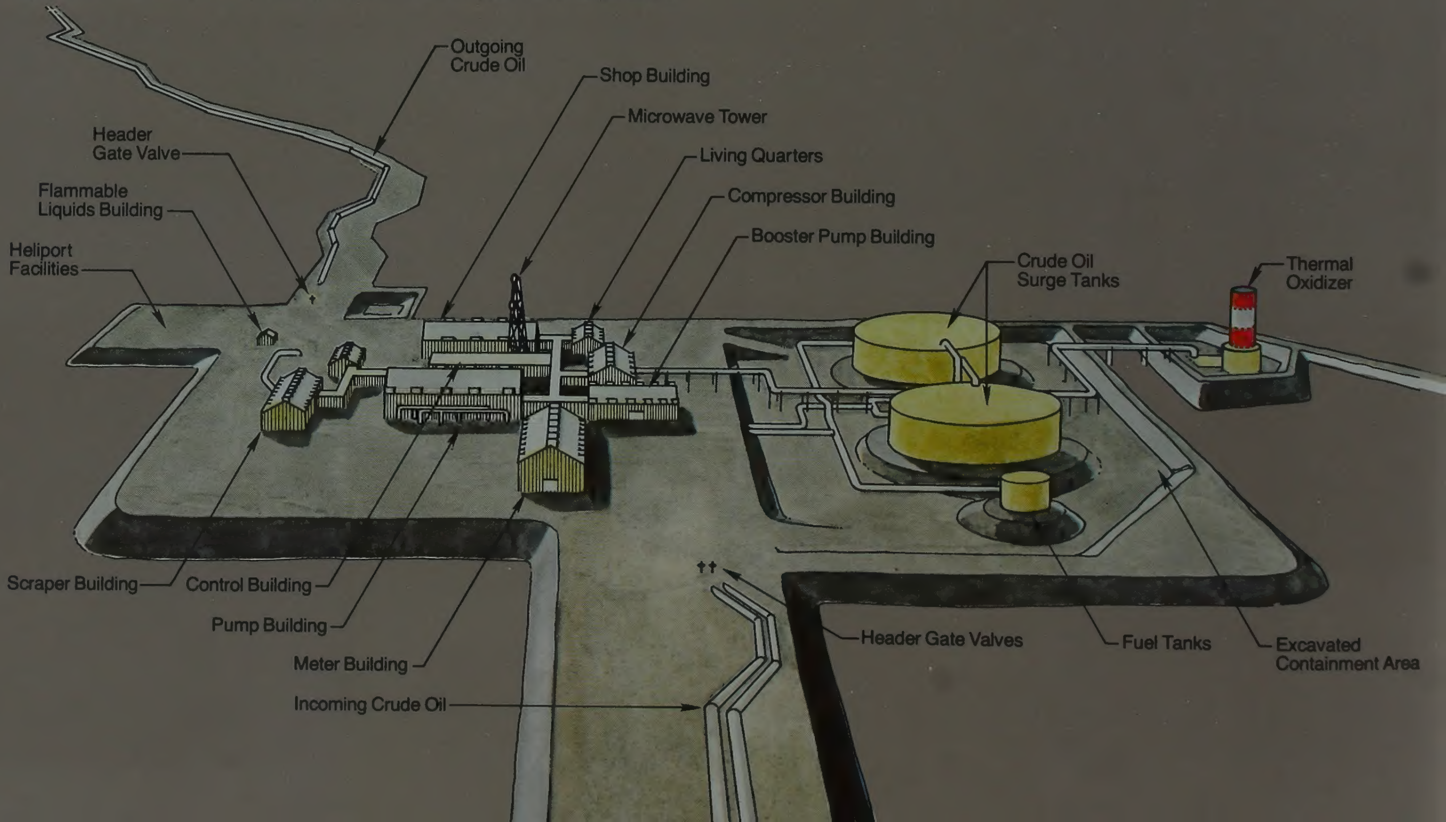
Hot gas provided by an aircraft-type jet engine drives a turbine wheel to power a mainline pump. Each engine can produce 13,500 horsepower. North of the Brooks Range, engines are fueled by natural gas from Prudhoe Bay, with turbine fuel available for standby. Three southern stations have

Seven of the eight operating stations have three mainline pumps, including one for standby.



Pump Station 1 (Origin Station)

This station alone has facilities to receive oil from producers, including metering and vapor control systems, three booster pumps and two 210,000-barrel surge tanks.



topping plants to produce turbine fuel for all other stations.

All gas turbines have filters to prevent snow and ice accumulation in the air intakes. Ingestion of large chunks of snow or ice could result in unit shutdowns or damage.

Crude oil relief tanks at the pump stations were built with cone roofs to withstand snow loads and to meet environmental emission requirements. All are equipped with mixers which assure uniform tank temperatures and prevent deposits of sediment or wax on tank bottoms.

The tanks accommodate surges and drain-down oil during emergencies, maintenance and repair. A pressure-relief system automatically detects and relieves excessive pipeline pressure. When actuated, the valves divert oil from the pipeline to the tanks. The oil is reinjected into the mainline by booster pumps as soon as normal conditions resume.

Electrical power is generated at most stations, and at Stations 8, 9, 11 and 12 is purchased from commercial power sources. All stations have a back-up, lifeline power generation system.

A loss of electrical power at a station would not affect operation of mainline pumps because mainline turbines generate their own electrical power. Supervisory and communications equipment continue in operation using batteries which can sustain operation for about eight hours.

Pump station buildings and walkways, which house equipment and in which station personnel work, are heated and provided with fresh air ventilation. Most areas are heated with a heat-medium circulating system in which a fluid is pumped through heat exchanger coils in a heater and then circulated by pump to heat-use locations in the station. The heaters, capable of producing 15 million BTUs an hour, can burn either natural gas or turbine fuel. Therminol 44 is the heat-medium fluid.

Pump station buildings are ventilated with a positive pressure fan or a blower-driven supply of outside air. In most areas, except living quarters, the air is heated by passing it over a heat exchanger. The system is designed to provide a minimum of four air changes every hour to remove traces of hydrocarbon vapors and maintain a healthful environment. Under normal circumstances, building temperatures can be maintained at about 68 degrees Fahrenheit even when outside temperatures have dropped to minus 60 degrees.

Fire and vapor detection systems are installed in all pump station buildings, and all buildings are protected by fire suppression systems.

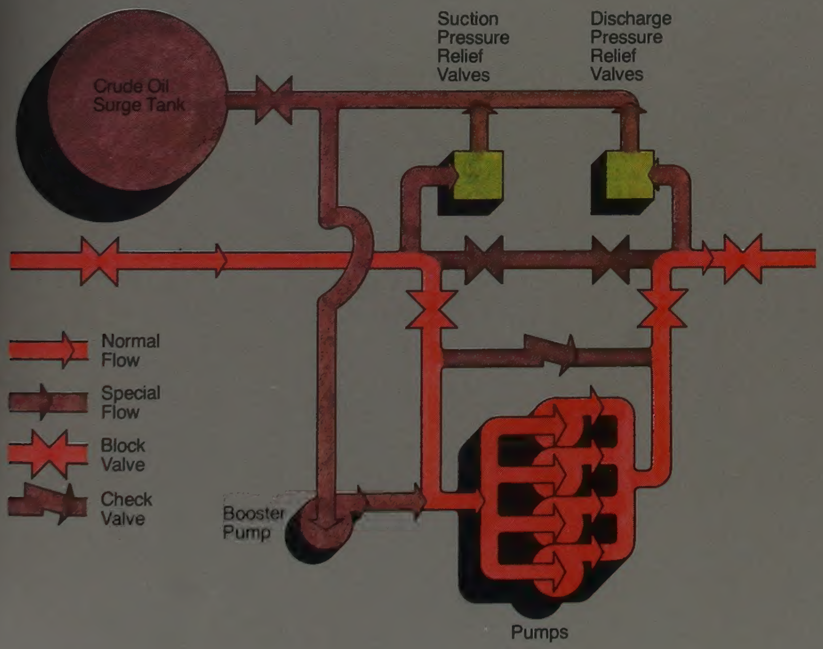
If hydrocarbon vapors in an area or zone reach 20 per cent of the lower flammable limit, the system sounds an alarm and activates high-speed ventilator fans. If fans fail to correct the situation and gas concentrations reach 70 per cent of the lower flammable limit, equipment in the area is shut down.

Detectors of products of combustion, flame and heat initiate alarms throughout the station and in the station's control room. The flame, heat and vapor detection systems stop all heating and ventilating fans and close all building dampers prior to actuation of suppression systems.

Halon 1301 gas is discharged

Typical Pump Station Oil Flow

Oil is pushed through the pipeline by mainline pumps at each station. Valves also make it possible to stop the flow or to bypass the pumps.



Pump station facilities are housed in interconnected structures designed for Arctic conditions.

manually or automatically to prevent ignition or extinguish fires. Cylinders of the extinguishing gas are located in or close to the areas they protect, with the number and size of the gas cylinders dependent on the concentration of halon required.

Pump Station 1

Pump Station 1, the receiving station for Prudhoe Bay crude oil, has several facilities not necessary at other stations. These include a system of meters for measuring incoming crude oil, a vapor control system, three booster pumps and two 210,000-barrel surge and relief tanks.

The station's metering system measures all oil received from the Prudhoe Bay producing facilities operated by Sohio-BP Alaska and Atlantic Richfield Company. Normally, oil from producers is moved to the surge tanks which accommodate any differences between flow rates from producers and the pipeline pumping rate. The tanks are equipped with mixers and heating elements designed to keep the temperature of stored oil at a minimum of 40 degrees Fahrenheit. Oil comes out of the ground at up to 180 degrees Fahrenheit and reaches Pump Station 1 at about 135 degrees.

Booster pumps deliver the oil from the tanks directly to the mainline pumps. The three two-stage booster pumps are driven by 1,140-horsepower gas turbines and each is designed to pump 19,750 gallons of oil a minute.

Station 1 also is equipped with a vapor recovery system, which eliminates hydrocarbon emissions to the atmosphere from its two crude oil surge tanks. Space in the tanks above the crude oil normally is filled with natural gas from the North Slope fuel gas line. As the tanks are filled with oil, gas and hydrocarbon vapors from the crude oil are drawn off and "scrubbed" in a process that removes liquids. Excess gas then either is injected into the station fuel gas line or burned in a smokeless incinerator at 2000 degrees Fahrenheit.

Natural gas from the Prudhoe Bay oil fields is piped to Station 1, metered, and then flows through a small-diameter line to the other pump stations north of the Brooks Range where it is used to power the gas turbines. The gas reaches Pump Station 1 at between 800 and 1,200 pounds per square inch. A scraper can be launched into the gas pipeline at Station 1 to clean the pipe to its terminus at Station 4, where a gas scraper receiver trap is located.

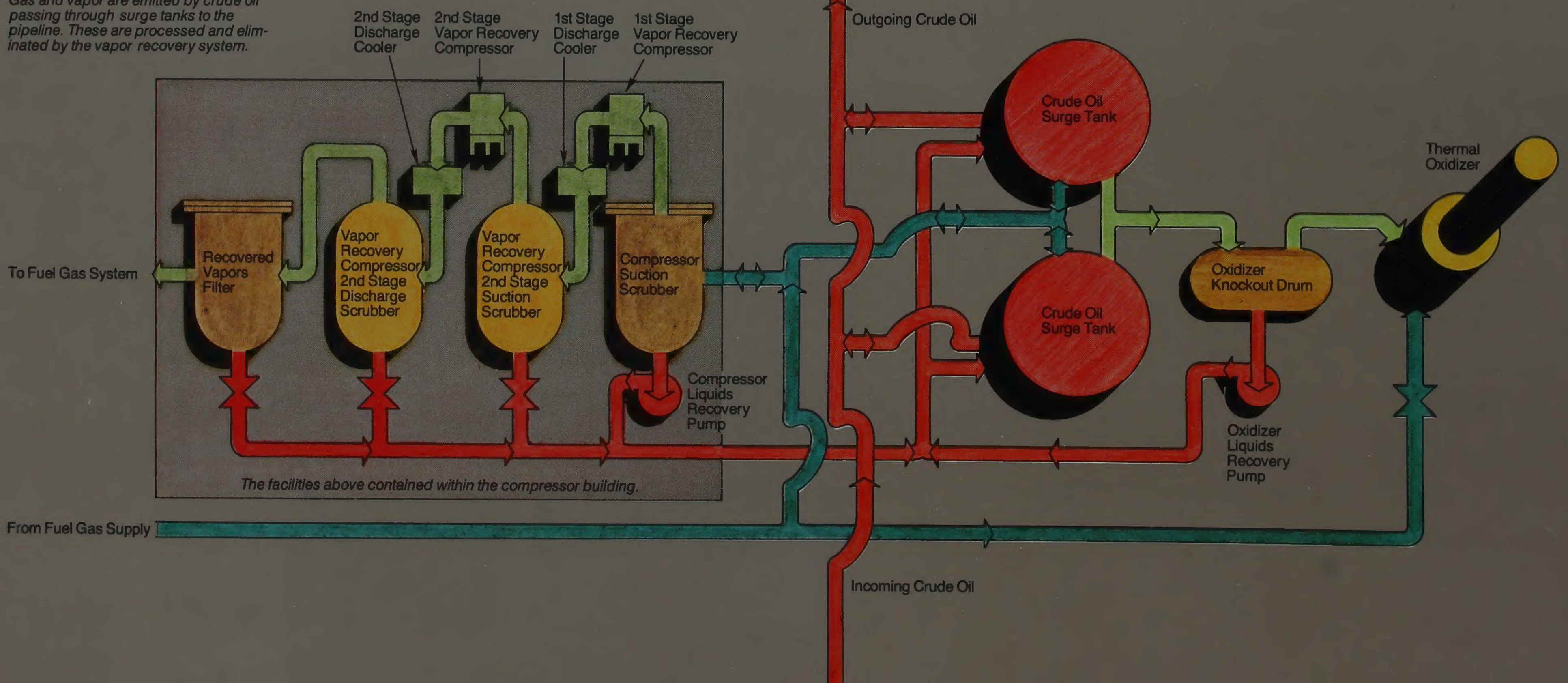
Pump Station 5

Pump Station 5, the first station south of the Brooks Range, currently functions as a pressure relief station. If pipeline flow stops, oil from Atigun Pass is drained into the tank at Pump Station 5 to avoid a buildup of pressure in the line. The 150,000-barrel storage tank is equipped with a heater and mixer. Mainline pumps will not be installed at the station unless the capacity of the line is increased above 1.16 million barrels a day.

During normal operation, incoming pipeline crude oil passes through the manifold building and flow meters and then back into the 48-inch pipeline. Whenever pressure exceeds established limits, quick-acting control valves divert oil to the crude oil relief/storage tank. There are three high-

Pump Station 1 Vapor Recovery System

Gas and vapor are emitted by crude oil passing through surge tanks to the pipeline. These are processed and eliminated by the vapor recovery system.


2nd Stage Discharge Cooler
2nd Stage Vapor Recovery Compressor
1st Stage Discharge Cooler
1st Stage Vapor Recovery Compressor
Outgoing Crude Oil
Crude Oil Surge Tank
Thermal Oxidizer
To Fuel Gas System
Recovered Vapors Filter
Vapor Recovery Compressor 2nd Stage Discharge Scrubber
Vapor Recovery Compressor 2nd Stage Suction Scrubber
Compressor Suction Scrubber
Oxidizer Knockout Drum
Crude Oil Surge Tank
Compressor Liquids Recovery Pump
Oxidizer Liquids Recovery Pump
The facilities above contained within the compressor building.
From Fuel Gas Supply
Incoming Crude Oil

volume relief valves in the suction (incoming) line and two in the discharge line.

Two injection pumps and a booster pump are used to inject oil from the tank back into the main pipeline. The two-stage, centrifugal injector pumps, driven by 1,100-horsepower gas turbine units, each can pump 100,000 barrels a day. The station's single booster pump, powered by a 400-horsepower electric motor, is used to boost oil at low pressures to the injection pumps.

Scraper

Scrapers, usually called "pigs," are sent through the pipeline with crude oil, either to scrape accumulated wax and other material from the inside of the pipe, or to measure the curvature and ovality of the pipe. These are put into the line or removed from it at three pump stations and the Valdez Terminal.

Pump Station 1 has a launching facility. Launchers and receiver traps are installed at Stations 5 and 10. The Valdez Terminal has a receiver trap only. At other stations, the moving pig, without being taken from the line, automatically is passed through the manifold without interrupting mainline pumps, by a system of bypass valves.

A pig is launched at one launching station and removed at the next receiver station. The pig then may be relaunched to continue down the line or be removed and trucked back to its launching station.

Station scraper facilities are equipped with cranes, necessary valves, drain sumps, audible alarms and a signal system linked to pump station control rooms.

Stations without launchers or receivers are equipped with pig arrival and departure signals and with valves needed to pass the scraper through the pump station manifold without stopping the flow of oil.

Traps, whether for receiving or launching, consist of a launching or receiving tube; a trap closure and tray assembly mounted on steel tracks, which removes or inserts the pig; winch assemblies for moving the trap closure assembly and the pig in or out of the tube; and a portable hydraulic pig puller-pusher device for positioning the scraper on the trap closure tray.

All traps are equipped with pressure interlocks which prevent them from being opened when inlet valves have not closed or when there is pressure in the trap.

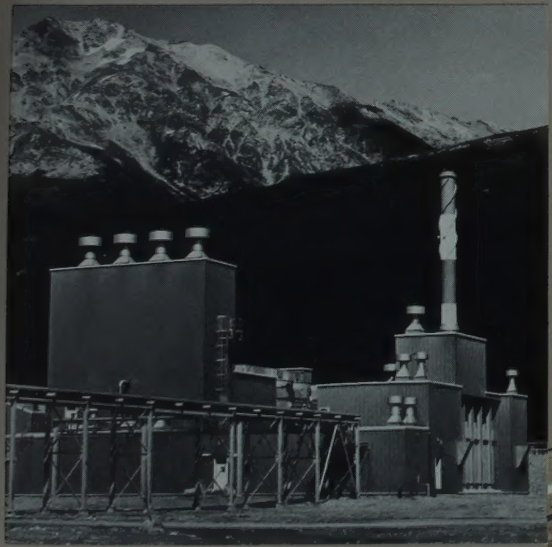
The typical scraper, or cleaning pig, consists of spring-mounted scraper blades and brushes on a central body with cone-shaped cups front and rear. The entire assembly fits the curvature of the 48-inch pipe. The blades and brushes scrape deposits of paraffin and other material from the interior walls of the pipe, and these deposits either redissolve or travel in the crude oil stream to the receiving traps at Pump Stations 5 and 10 and the Valdez Terminal. Cleaning pigs are run through the line on a regular basis.

Topping Plants

Small refineries, or topping plants, at Pump Stations 6, 8 and 10 produce a kerosene-type turbine fuel for jet engines driving pumps at stations south of the Brooks Range.

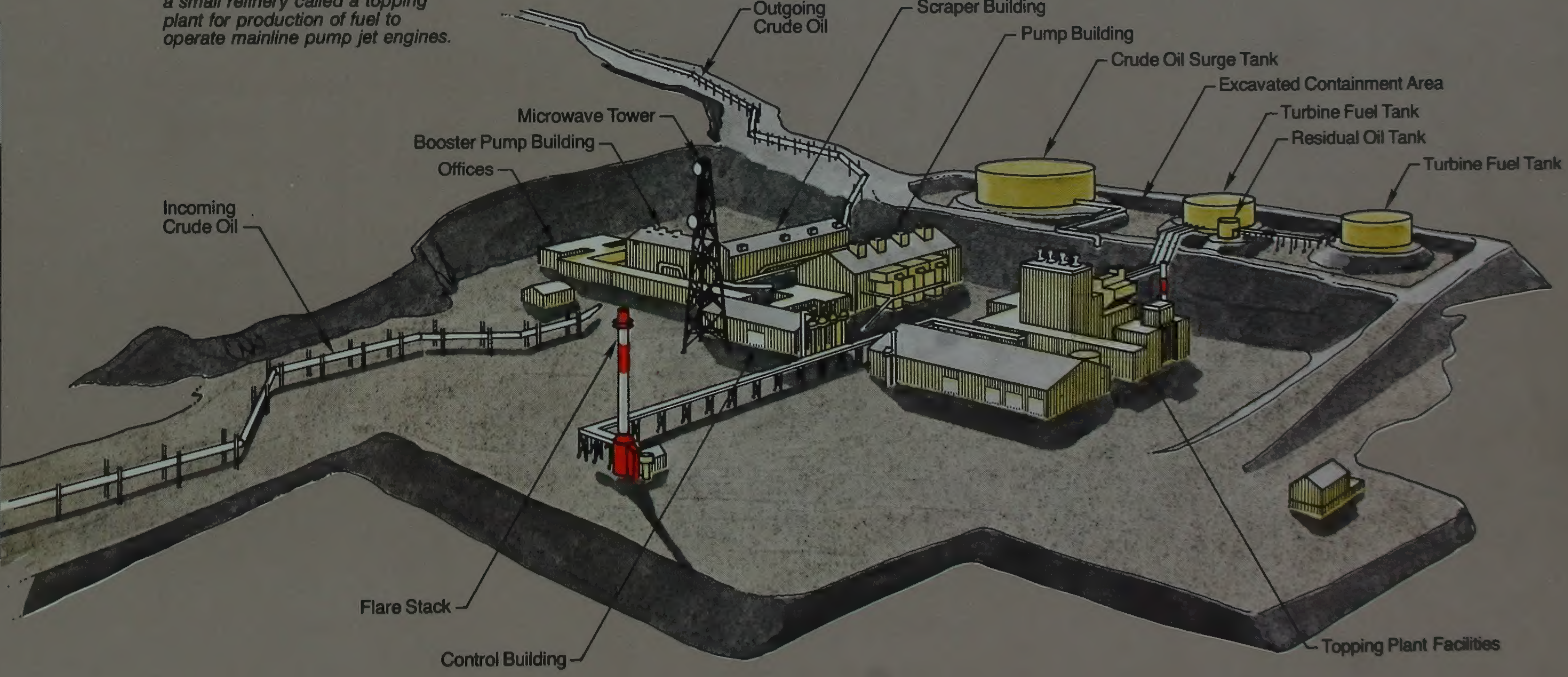
The topping units process crude oil from the pipeline at the

Topping plants at Pump Stations 6, 8 and 10 produce turbine fuel.



Pump Station with Topping Plant

Pump Stations 6, 8 and 10 include a small refinery called a topping plant for production of fuel to operate mainline pump jet engines.



rate of 10,000 barrels a day, producing about 2,000 barrels of turbine fuel. The crude oil removed from the line is preheated and then pumped through a heater to a distillation tower at 595 degrees Fahrenheit. In the tower, heavy oil products are pumped from the bottom, cooled and returned to the pipeline. Turbine fuel is drawn from the side of the tower at 465 degrees. Lighter fractions which rise to the top of the tower are condensed, cooled and also returned to the pipeline.

Processed fuel is stored in 40,000-barrel tanks at the topping unit stations. Fuel from the topping units is delivered by truck to adjacent stations.

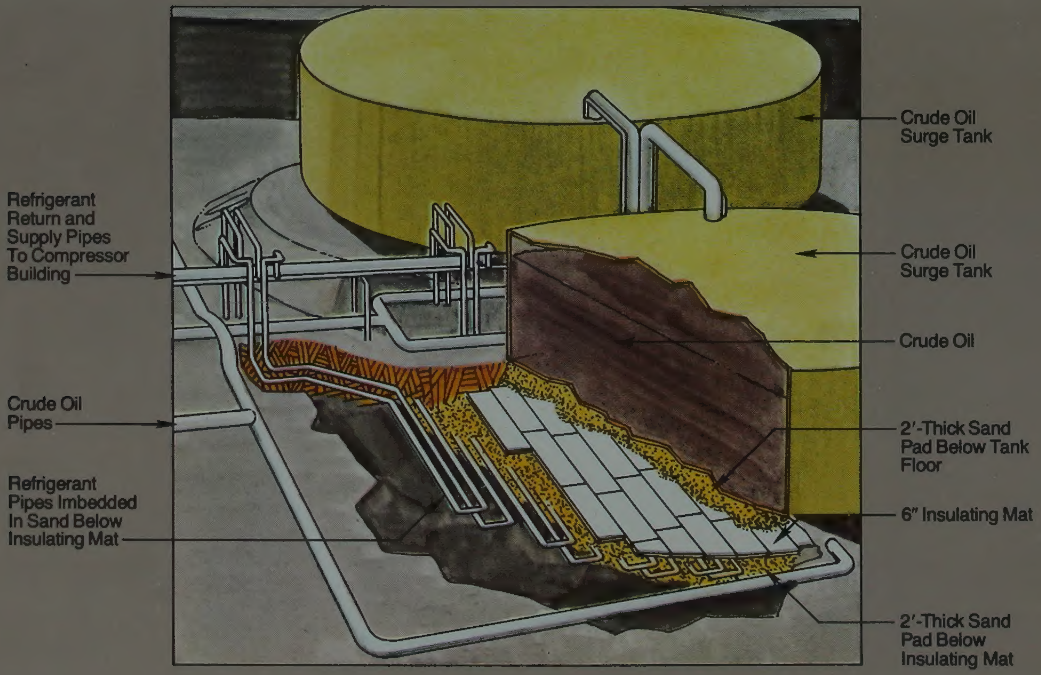
Refrigerated Sites

Pump Stations 1, 2 (a possible future station), 3, 5 and 6 are in permafrost areas. To maintain the stability of the permanently frozen soil, ground under most buildings and tanks is refrigerated. Coils of pipe for circulating brine are buried in gravel beneath mats of plastic foam insulation to keep the soil frozen and stable.

Mechanical refrigeration units chill a calcium chloride brine that is circulated in the subsoil piping loops at approximately 5 degrees Fahrenheit. Each unit contains two refrigerant compressors, two air-cooled condensers, two liquid refrigerant receivers, a brine chiller and interconnecting plumbing. The units, housed in station buildings, are controlled from station control rooms. Temperature detectors wired to indicator alarms automatically monitor system operation.

Pump Station Refrigerated Site Details

Mechanical refrigeration systems have been built under facilities at Pump Stations 1, 2, 3, 5 and 6 to maintain permafrost stability.


Refrigerant Return and Supply Pipes To Compressor Building
Crude Oil Pipes
Refrigerant Pipes Imbedded In Sand Below Insulating Mat
Crude Oil Surge Tank
Crude Oil Surge Tank
Crude Oil
2′-Thick Sand Pad Below Tank Floor
6″ Insulating Mat
2′-Thick Sand Pad Below Insulating Mat

Pump Station 2 (one of four possible future stations, along with 5, 7 and 11) is among the five located on permafrost, with mechanical refrigeration units installed beneath facilities to maintain the soil in a frozen condition.

The Pipeline

Operation activities on the trans Alaska pipeline center largely in pump stations and the Terminal. The 800 miles of pipe, which carry the oil from Prudhoe Bay to Valdez, play a purely passive role. However, design and construction of the pipeline involved a number of complex problems and unique solutions.

Most pipelines are buried below ground. But because of permafrost conditions across Alaska, about half of the trans Alaska line is built above ground and several short buried sections are specially refrigerated.

The method chosen for emplacement of pipe along the route depended, for the most part, on soil conditions and the effects of pipeline heat on the soil. In stable soils such as rock, in thaw-stable sands and gravel, or in conditions where thawing would not cause unacceptable disruption of terrain, the line is buried in a conventional manner. The pipe was placed on a layer of bedding material in a ditch three to 16 feet deep and then covered with prepared gravel padding and dirt fill material.

In places where melting permafrost might create difficult soil stability conditions, the pipeline was built above ground. In this mode, the pipe is supported by crossbeams installed between vertical supports placed in the ground. The pipe itself, insulated with four inches of fiberglass and jacketed with galvanized steel, is mounted on Teflon-coated shoe assemblies which can slide on the crossbeams.

Thawing around the vertical supports is prevented by thermal devices, called heat pipes, which are installed as necessary inside the supports. Inside the self-contained heat pipes is a refrigerant which vaporizes below ground, then rises and condenses in the above-ground radiators, removing ground heat whenever the ground temperature exceeds the temperature of the air.

To allow for contraction and expansion of the above-ground pipe because of temperature changes (temperatures before start-up ranged down to minus 70 degrees Fahrenheit, but oil temperatures may reach as high as 145 degrees), above-ground sections were built in a flexible trapezoidal zigzag configuration. In this design, longitudinal expansion of the pipe is converted into a sideways movement. The configuration also accommodates pipe motion induced by an earthquake.

Anchor structures, erected every 800 to 1,800 feet, hold the pipe in position. Between anchors, however, the pipe can move on the crossbeams 146 inches due to thermal expansion and contraction and an additional 24 inches due to seismic activity. At points where potential earthquake movement might be larger, bumpers have been installed on supports to limit movement of the pipe and absorb the energy of its impact.

At the Denali Fault, the only major geologic fault crossed by the line, design permits as much as 20 feet of horizontal and 5 feet of vertical motion.

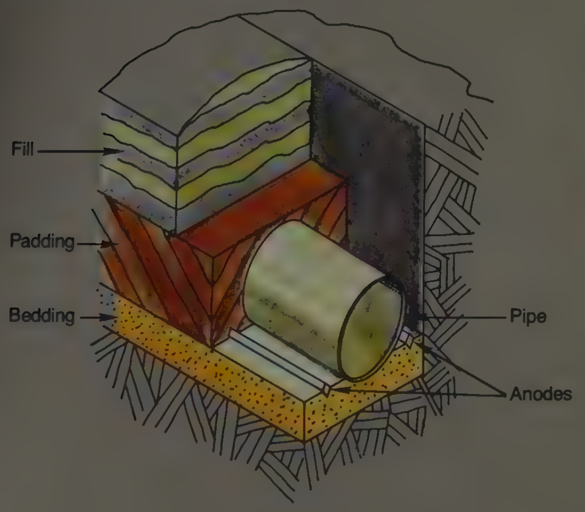
At one highway crossing and two points where caribou migration routes cross the pipeline in permafrost soils, the pipe is buried in a refrigerated ditch. Refrigeration plants at each point circulate chilled brine through loops of six-inch pipe to maintain soils in a stable, frozen condition.

At more than 800 river and stream crossings, the pipe either bridges the waterway or is buried beneath it. At most small streams, the elevated pipe bridges the water on conventional supports. At 14 places, however, special bridges were built. Pipe across the Yukon River is attached to a newly constructed highway bridge. Standard plate girder structures were built at 10 crossings. Special suspension bridges were constructed across the Tanana and Tazlina rivers, and a tied-arch bridge was designed for the Gulkana River.

A total of 151 gate and check valves were placed in the line.

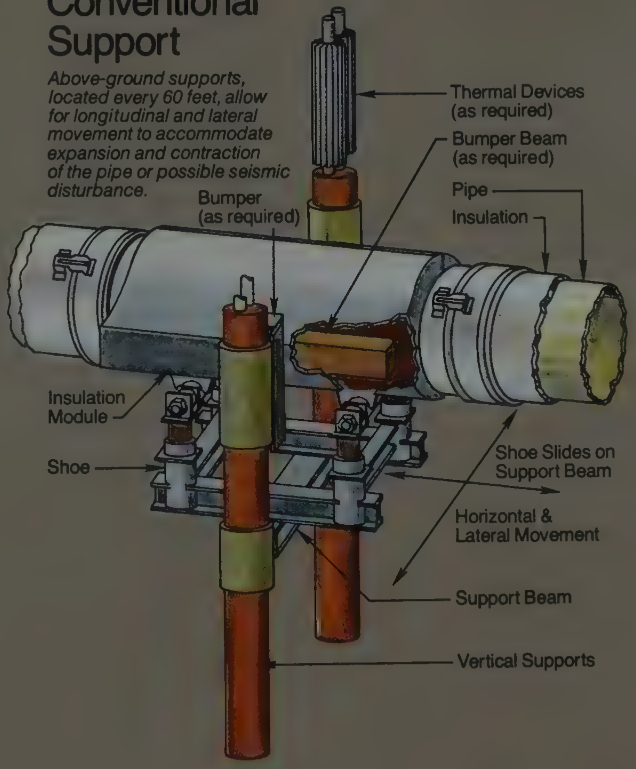
Conventional Burial

Burial, a normal pipelaying technique, is used where soil and permafrost conditions permit.



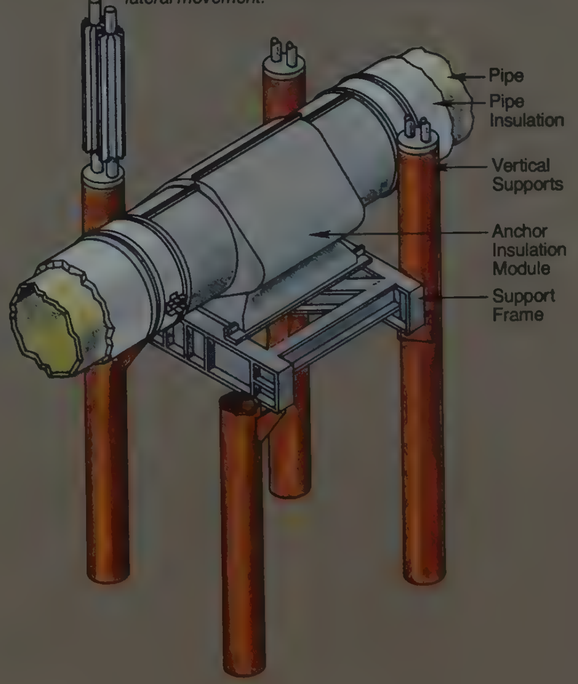
Conventional Support

Above-ground supports, located every 60 feet, allow for longitudinal and lateral movement to accommodate expansion and contraction of the pipe or possible seismic disturbance.


Thermal Devices (as required)
Bumper Beam (as required)
Pipe
Insulation
Bumper (as required)
Insulation Module
Shoe
Shoe Slides on Support Beam
Horizontal & Lateral Movement
Support Beam
Vertical Supports

Anchor Support

Erected every 800 to 1,800 feet, these supports hold the line in position. All other supports allow for longitudinal and lateral movement.



Eighty-seven valves protect stream crossings, 10 protect population areas and three protect sites where the environment is especially sensitive. Spacing of the valves limits the size of any potential leak.

Check valves, which are held open by flowing oil and close automatically when oil flow stops or is reversed, prevent the reverse flow of oil on uphill sections of the line should the line break. Gate valves, generally on flat terrain and downhill slopes, isolate sections of the line, and thus limit spills. Sixty-two of the 71 gate valves can be closed and opened by the Pipeline Controllers in Valdez. All valves can be operated manually for maintenance of the line.

The pipe itself was specially engineered and fabricated for the trans Alaska line. It was manufactured in three grades, with minimum yield strengths of 60,000, 65,000 and 70,000 pounds per square inch, and in two wall thicknesses: .462 and .562 inch.

The pipe was coated and wrapped for protection from bacteriological, chemical and electrolytic corrosion. In buried modes, zinc ribbons buried with the pipe serve as sacrificial anodes. They prevent a flow of current away from the pipe which would corrode its metal surface.

As pipe emerges from burial to an above-ground section, it resumes its zig-zag path.

The pipeline is allowed sideways motion of up to 20 feet in the Denali Fault area.

Terminal

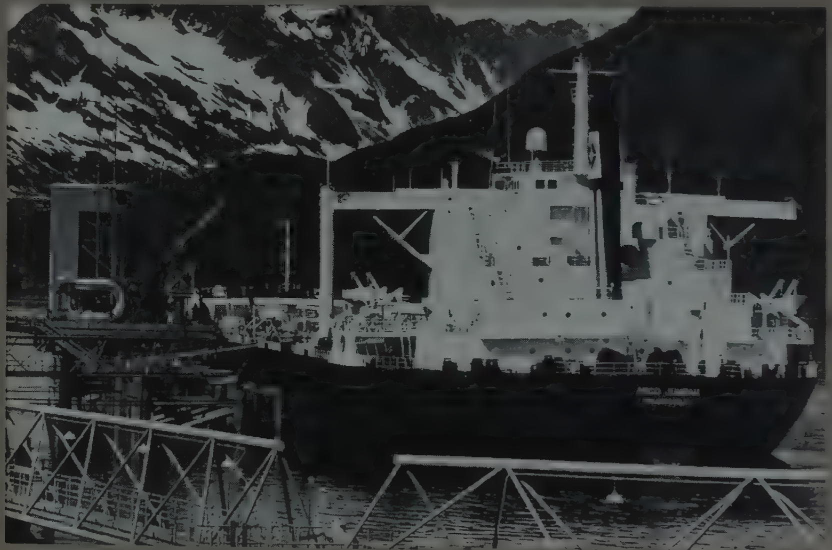
Oil, after being moved through pump stations and the pipeline from Prudhoe Bay, is stored and loaded aboard tankers at the Terminal on the south shore of Port Valdez.

The 1,000-acre site, across the port from the city of Valdez, is in an 11-mile-long fiord in the northeast corner of Prince William Sound. It is the northernmost ice-free harbor in the United States, and offers a deep-water channel with a minimum width of approximately 3,000 feet.

Facilities at the Terminal include everything necessary for storing and loading oil aboard tankers. Storage facilities include 18 cone-roof tanks with a total capacity of 9,180,000 barrels of oil. Tanker loading facilities include one floating and three fixed berths which handle tankers of 16,000 to 265,000 deadweight tons at loading rates up to 110,000 barrels an hour.

Shore facilities include a vapor recovery system, ballast water treatment plant, power plant, warehouses and shop buildings, meters and meter-proving equipment, water treatment and sewage systems, heating systems, oil spill contingency equipment, firefighting systems, fuel storage and the Operations

The pipeline ends with its links to tankers at the Valdez Terminal.



Control Center for the entire pipeline system.

Incoming oil enters the Terminal through the last pipeline gate valve, and passes through Terminal meters where it is measured. The incoming stream is checked routinely for temperature, vapor pressure, specific gravity and viscosity.

Other metering systems measure oil loaded into tankers. Sixteen-inch turbine meters are operated in parallel sets to measure flow, with the number of meters determined by flow rate. Each turbine meter can measure 25,700 barrels per hour. Meters are calibrated routinely by a meter proving system. In the prover, a "prover ball" is moved by oil flow through a carefully calibrated length of pipe. Measurement is accomplished as the device trips switches at the beginning and end of its journey through the pipe. Volume readings, reported by the meters during that period, then are adjusted to conform to the known volume of the prover loop.

Incoming facilities include a scraper, or pig, trap and pressure relief valves. Incoming pigs are received in a scraper trap in the East Metering Building, then trucked north for re-use. Scraper facilities include the trap, its valves, arrival indicators and a sump and sump pump.

Relief valves prevent incoming oil pressure from exceeding design limits. Surge or static pressure of more than 300 pounds per square inch causes these valves to open and divert oil directly to two crude relief tanks. The valves open and close automatically.

Storage tanks at the Terminal are 250 feet in diameter with a capacity of 510,000 barrels of oil each. The 18 tanks will hold about 7½ days of pipeline throughput at the 1.16 million-barrel-per-day rate.

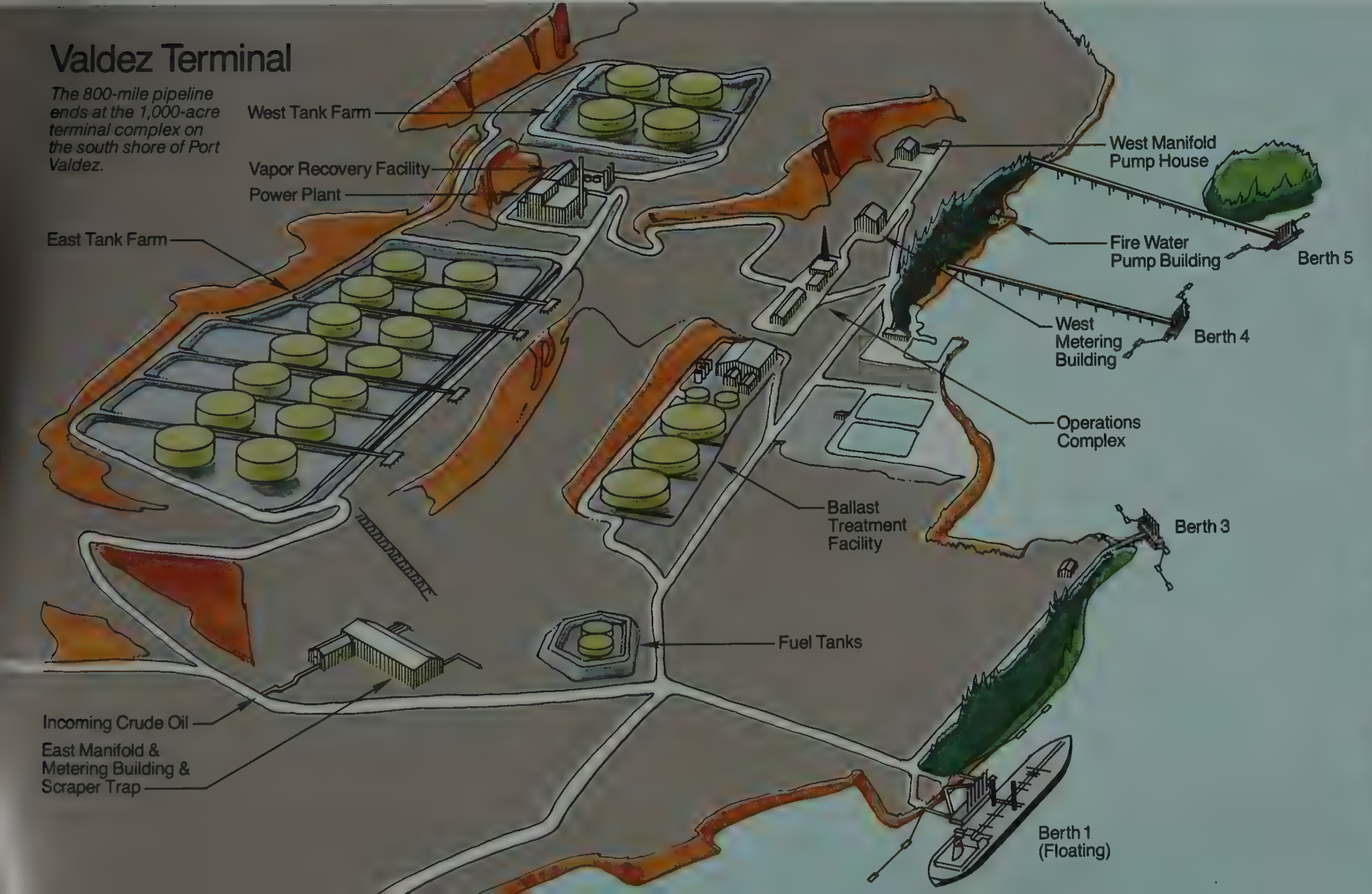
Tanks, 62 feet 3 inches high, have a maximum product height of 58 feet 6 inches. The difference provides a 3-foot 9-inch slosh zone to allow oil movement caused by seismic forces as great as 8.5 on the Richter Scale. Each tank has three mixers to prevent stratification of the oil, level and temperature gauging instruments, and instruments designed to control the tank vapor space pressure and the positions of all valves.

Tanks are arranged in pairs having the same elevation. Each pair is surrounded by a dike which can hold 110 per cent of the oil in both tanks plus water that might be impounded in the area.

Each tank receives inert gas from the vapor recovery system through a 16-inch connection on the tank roof. The space between oil and the roof of each tank always contains inert gas rather than air. Any excess inert gas and hydrocarbon vapors are collected via a 30-inch line on the roof and are used to blanket other tanks, or are incinerated.

Tanks are equipped with 10 to 14 automatic pressure/vacuum vents which operate only in event of failure of the vapor recovery system.

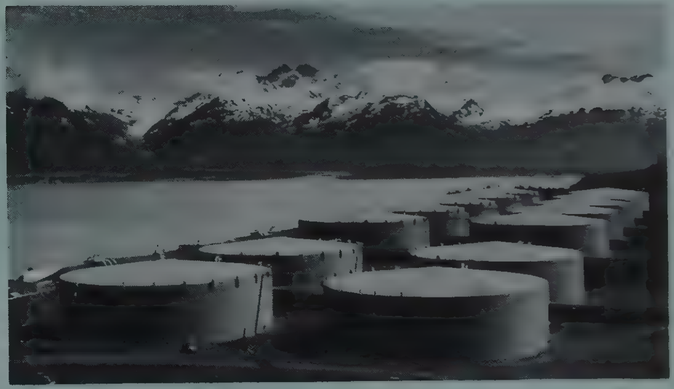
The tank farm fire control system consists of subsurface foam injection systems inside the tanks and a water system which can provide cooling water on tank exteriors (see fire control). Crude transfer pumps can move oil from one tank to



Valdez Terminal

The 800-mile pipeline ends at the 1,000-acre terminal complex on the south shore of Port Valdez.

Pairs of storage tanks at the Terminal's East Tank Farm are surrounded by containment dikes.



Oil pipes and vapor recovery system lines from two pairs of tanks travel along a common pipe-carrying wall.

another anywhere in the tank system.

Berths at the Terminal have been numbered 1, 3, 4 and 5. Berth 1 is a floating berth; the others are conventional fixed berths. The floating berth handles tankers of 16,000 to 120,000 deadweight tons, Berth 3 handles tankers up to 250,000 DWT, and Berths 4 and 5 handle tankers up to 265,000 DWT or larger. Berth 1 also receives fuel from tankers for the Terminal's fuel supply.

The floating berth, located in an area where a steeply sloped sea bottom made conventional piling construction impractical, is held in position offshore by struts anchored to bedrock on shore. The floating structure is supported by buoys, each approximately 45 feet tall and 22 feet in diameter.

Shore struts support roadways, walkways, and oil, ballast water and service pipelines.

The fixed berths are mounted on steel structures of jacketed pile anchored to bedrock. Loading structures on these berths are approximately 122 feet long by 46 feet wide. All of the berths have mooring dolphins, or stanchions, of a conventional pile design to hold the ships' mooring lines. Mooring and breasting dolphins all are equipped with quick-release hooks which can be activated either manually or remotely by the berth operator.

A tower on each berth houses the berth operator's control room. From the tower, the operator has a clear view of the berth, the tanker deck and the port.

Oil is gravity-fed to tankers at each berth through four hydraulically controlled metal loading arms. Ship ballast also is pumped out through these arms. The four 12-inch arms at Berth 1 handle 80,000 barrels of oil an hour. The four 16-inch arms on the fixed berths have a capacity of 110,000 barrels an hour.

Flow control and quick-shutoff valves are provided at all berths to prevent excessive surge pressures and to control flow rates during loading. Work areas on the berths are surrounded by oil-tight curbs so that spillage can be collected and processed through the ballast water treatment facility.

The berths can be operated simultaneously and independently whether tankers are discharging ballast or loading oil.

Power Plant

The Terminal power generation facility provides electric power to the Terminal; a source of steam for various pump drivers, heating systems and vapor recovery incinerators, and inert flue gas for blanketing oil tanks.

The Terminal does not use commercial electric power. Besides its main power generation facility, the Terminal has two back-up power systems.

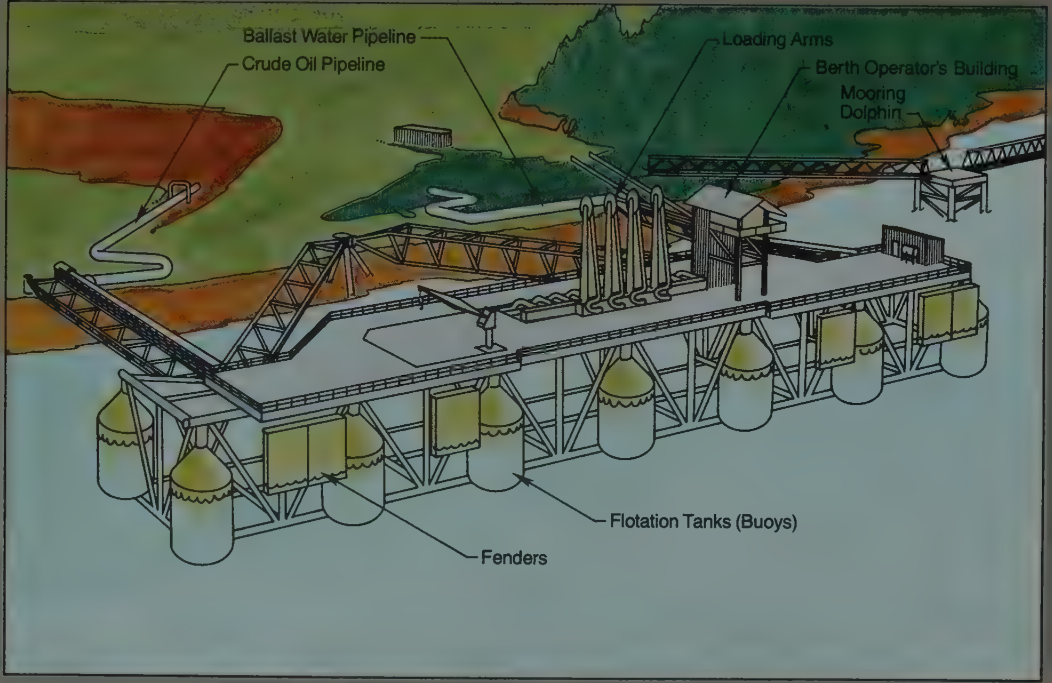
The power plant consists of three oil-fired boilers which generate steam, and three condensing turbo generators, each with a capacity of 12.5 megawatts. The systems can satisfy all Terminal power requirements even at the ultimate pipeline design flow rate of 2 million barrels per day.

Boilers for the power system are an oil-fired, forced-draft type. Water for the boilers is pumped from a nearby creek into a water treatment plant where it is filtered and demineralized before being deaerated and fed into the boilers.

The "lifeline" power system,

Floating Tanker Berth

Massive cylindrical buoys, as well as struts anchored to the shore, hold the Terminal's floating berth in position.



Struts extend from the shore to the floating tanker berth.

housed in the maintenance building, is intended for use in event of a power failure at the Terminal. It is a 12-cylinder diesel-driven generator with associated control and regulation equipment.

Four battery systems provide a third level of power for essential control equipment and instruments throughout the Terminal. The systems consist of batteries, chargers and distribution panels along with rectifiers, inverters, necessary transformers and switches.

Vapor Recovery System

The Terminal's vapor recovery facility consists of two main systems. The first provides inert gas blanketing for all oil storage tanks. The second system collects the inert gas and oil vapors from the tanks when they are being filled or when atmospheric conditions cause an increase in tank pressure. Both systems are linked to incinerators which burn any excess gases.

Flue gases from power plant boilers located next to the vapor recovery facility are used as the inert gas. The flue gas—approximately 70.3 per cent nitrogen, 17.9 per cent carbon dioxide, 9 per cent water vapor, 2.8 per cent oxygen and .06 per cent sulfur dioxide—is cooled and then "scrubbed" to remove the corrosive sulfur dioxide, and then sent to gas compressors and, ultimately, the tanks.

The sulfur dioxide is removed in caustic scrubbers which eliminate 90 per cent of the sulphur dioxide gas as it flows upward through a spray and over trays of scrubbing liquid. Any free water in the gas is separated in a suction knockout drum equipped with a demister screen.

The cooled and processed inert gas then is compressed and discharged to oil tanks as required.

When tanks are being filled or when atmospheric pressure decreases, tank vent valves open and allow gas — generally a mixture of hydrocarbon vapors and inert gas — to flow into the low-pressure collection system. After moisture has been removed and the gas has been compressed, it either is returned to tanks as blanketing gas or is burned.

Excess gases are burned in incinerators which oxidize all hydrocarbons to carbon dioxide and water vapor before discharge into the air. Fuel oil is used to maintain stack temperatures at 1400 degrees Fahrenheit.

Ballast Water Treatment

All ballast water discharged by tankers and all other oily waters collected in the Terminal area are processed through the ballast water treatment system before being discharged into Port Valdez.

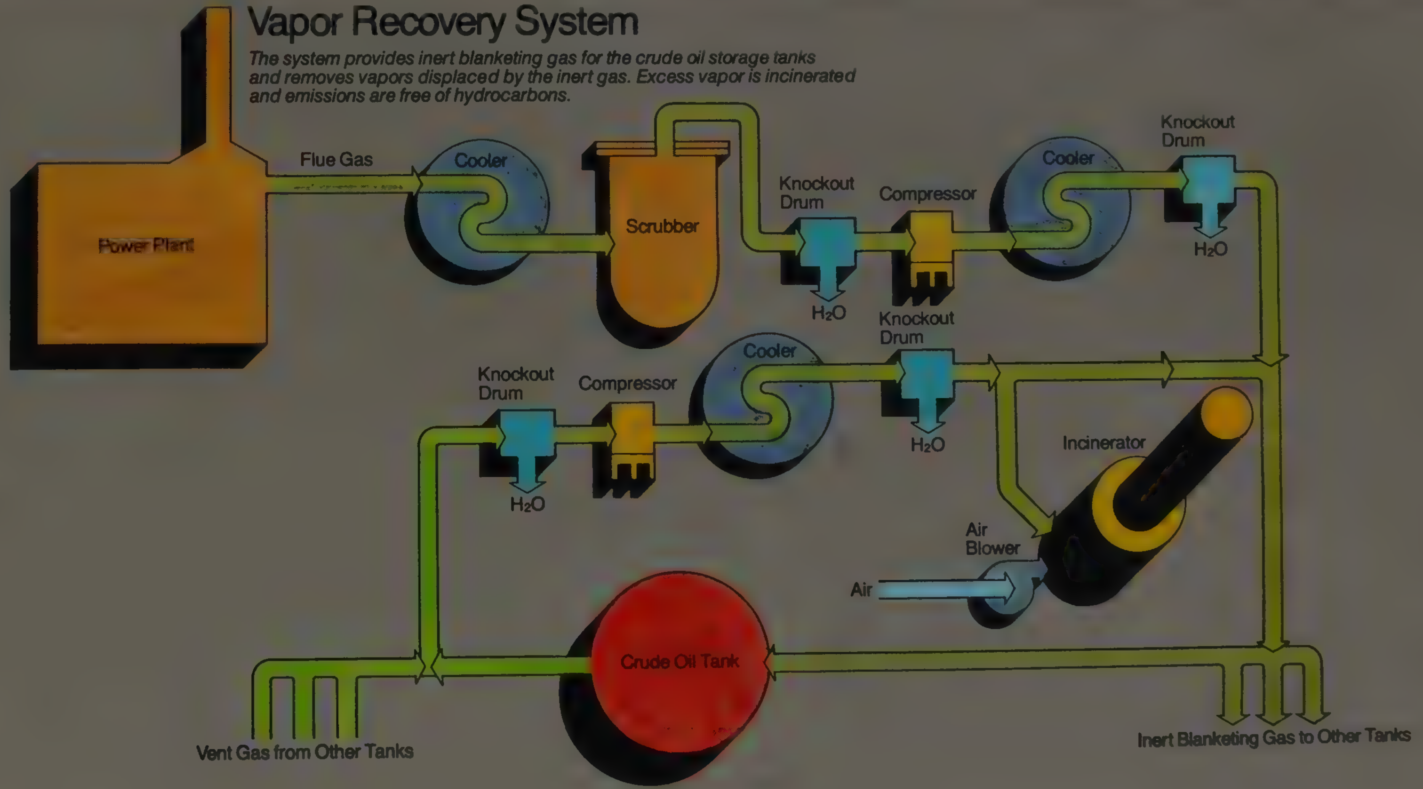
Tankers arriving at Valdez carry water ballast in their tanks for stability while traveling without a cargo of oil. This water must be removed before tankers can take oil, and, by law, ships must discharge all ballast into the treatment system. Tanker operators arriving at Valdez must certify that no ballast has been discharged at sea.

The Terminal treatment system consists of gravity separation tanks; a zone for chemically aided dissolved air flotation treatment; an effluent-holding reservoir, and a dewatering processor for recovered oil.

Ballast water is pumped first into gravity separation tanks

Vapor Recovery Building interior shows compressors and auxiliary equipment.

Key Terminal installations are the power plant (rear) and vapor recovery facilities



Vapor Recovery System

The system provides inert blanketing gas for the crude oil storage tanks and removes vapors displaced by the inert gas. Excess vapor is incinerated and emissions are free of hydrocarbons.

where it is allowed to remain undisturbed for about six hours to allow oil to rise to the surface. Two floating-boom skimmers remove oil from the surface and the remaining ballast is removed from the bottom of the tanks for secondary treatment.

In the second step, ballast water is piped to flocculation/dissolved-air flotation treatment chambers where coagulant chemicals are mixed with the ballast to cause suspended and colloidal materials to form particles referred to as "floc."

The water is aerated, and the bubbles cling to the floc, carrying it to the surface where it is skimmed for removal. The remaining water then flows to a basin where water is adjusted to the proper pH level, or acid/base balance. After being tested and approved, the cleansed water is discharged into Port Valdez at depths of 200 feet or more, 700 feet offshore.

The recovered oil and oil/water emulsion are reprocessed in the oil recovery area for eventual discharge into the main oil holding tanks. The process involves separation of the oil and water by gravity settling, and by processing in emulsion breaking and electrostatic treating units.

Fire Protection System

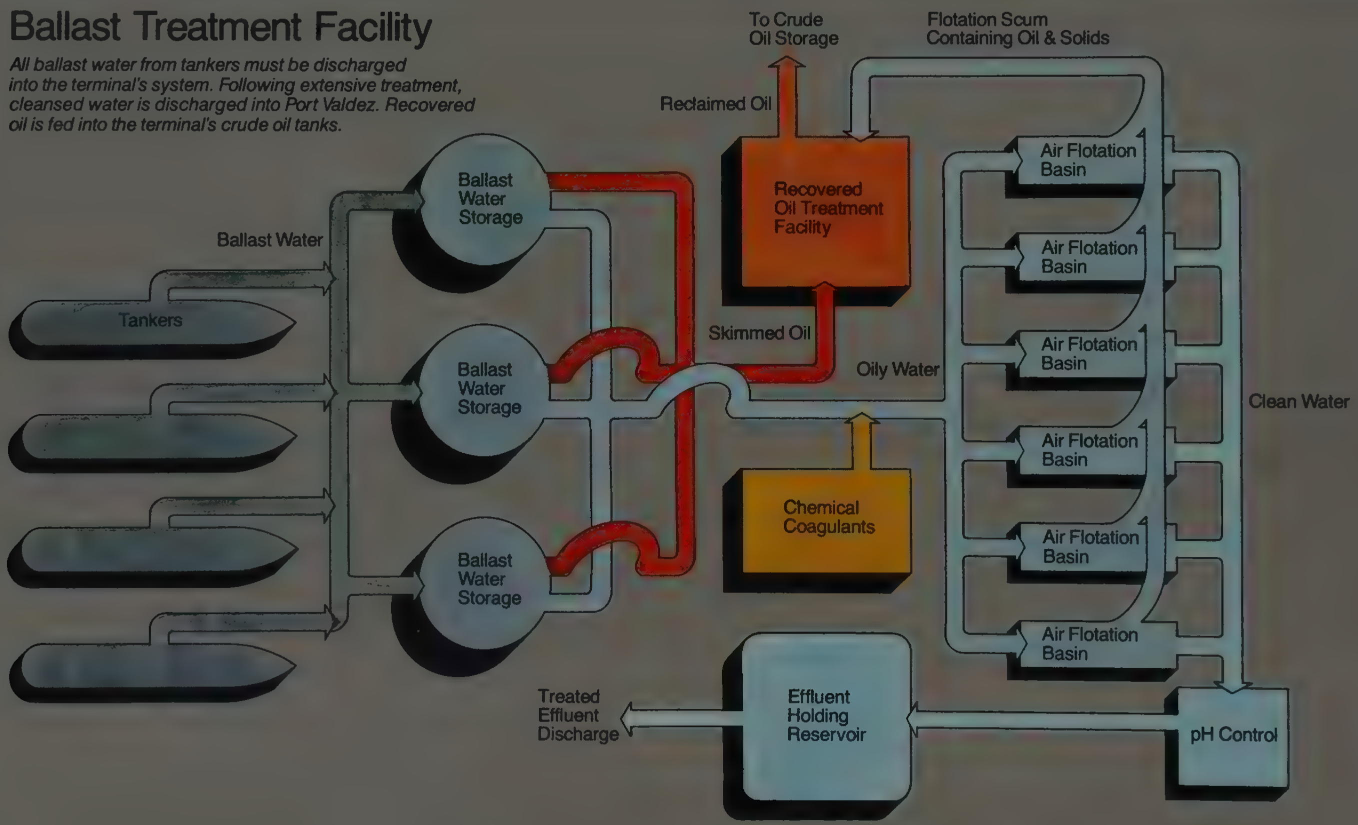
Water, foam, halon and dry chemical are used in the Terminal's extensive fire protection system which includes five fire trucks and other firefighting equipment. In event of a fire, a full-time fire chief directs efforts of a highly trained volunteer brigade of Terminal employees.

Sea water taken from Port Valdez by automatic-start diesel-powered pumps is used in the looped firewater system which has a 10,000-gallons-per-minute capacity. If fire occurs inside a tank, foam is injected below the surface of the stored oil, bubbling through the flammable liquid to form a blanket on the surface which suppresses vapor and extinguishes the fire.

Each berth has its own firefighting facilities consisting of firewater pump and foam systems. When a fire alarm is tripped, the flow of oil is stopped and the foam system blankets the loading area with foam.

Offshore are three tugs, equipped to deliver cooling water and foam, to supplement fixed firefighting systems on the berths. If fire occurred aboard a tanker, the tanker immediately would be moved from the berth area, and the tugs would supplement the onboard firefighting systems.

A halon extinguishing system is used in the flammable liquid storage room of the maintenance building and at the Operations Control Center. The ballast water treatment building is protected by a firewater foam system.



Ballast Treatment Facility

All ballast water from tankers must be discharged into the terminal's system. Following extensive treatment, cleansed water is discharged into Port Valdez. Recovered oil is fed into the terminal's crude oil tanks.

Operations

Although the pipeline consists of separate elements with different functions, the elements must be viewed as one system. Pump stations, pipeline and Terminal operate together to move Prudhoe Bay crude oil in an orderly, controlled manner to tankers at Valdez.

Control Center

This 800-mile-long system is controlled from the Operations Control Center at Valdez, where Pipeline and Terminal Controllers monitor and control almost every element.

The Pipeline Controller, aided by computers, a push-button control panel and data displays, monitors and controls the pipeline by remotely operating valves and pump stations.

Working at a console, the Controller can initiate actions at every operating level: He can start and stop mainline and booster pumps, shut down topping plants, control valves, isolate pump stations and start and stop the entire system.

The Terminal Controller likewise governs Terminal functions. From his console in the same control center he can direct the flow of pipeline oil to specific storage tanks and from the tanks to vessels at the berths. He monitors the operation of the Terminal's ballast water treatment facility, vapor recovery plant and tanker loading berths.

The Pipeline and Terminal Controllers also can initiate a wide range of emergency procedures in case of any problems on the line, in the pump stations, or at the Terminal.

Many operations on the line can be controlled locally. At the Terminal, tanker loading is handled by berth technicians after the Terminal Controller has issued a permissive control. The Terminal ballast treatment plant is operated from its own control room with the Terminal Controller monitoring all alarm conditions.

Each pump station, likewise, can assume local control of equipment in case of emergency or during repairs. Stations, however, can assume local control only with permission of the Pipeline Controller.

Monitoring the System

In monitoring the pipeline and pump stations, the Pipeline Controller receives a constant flow of information about conditions along the line.

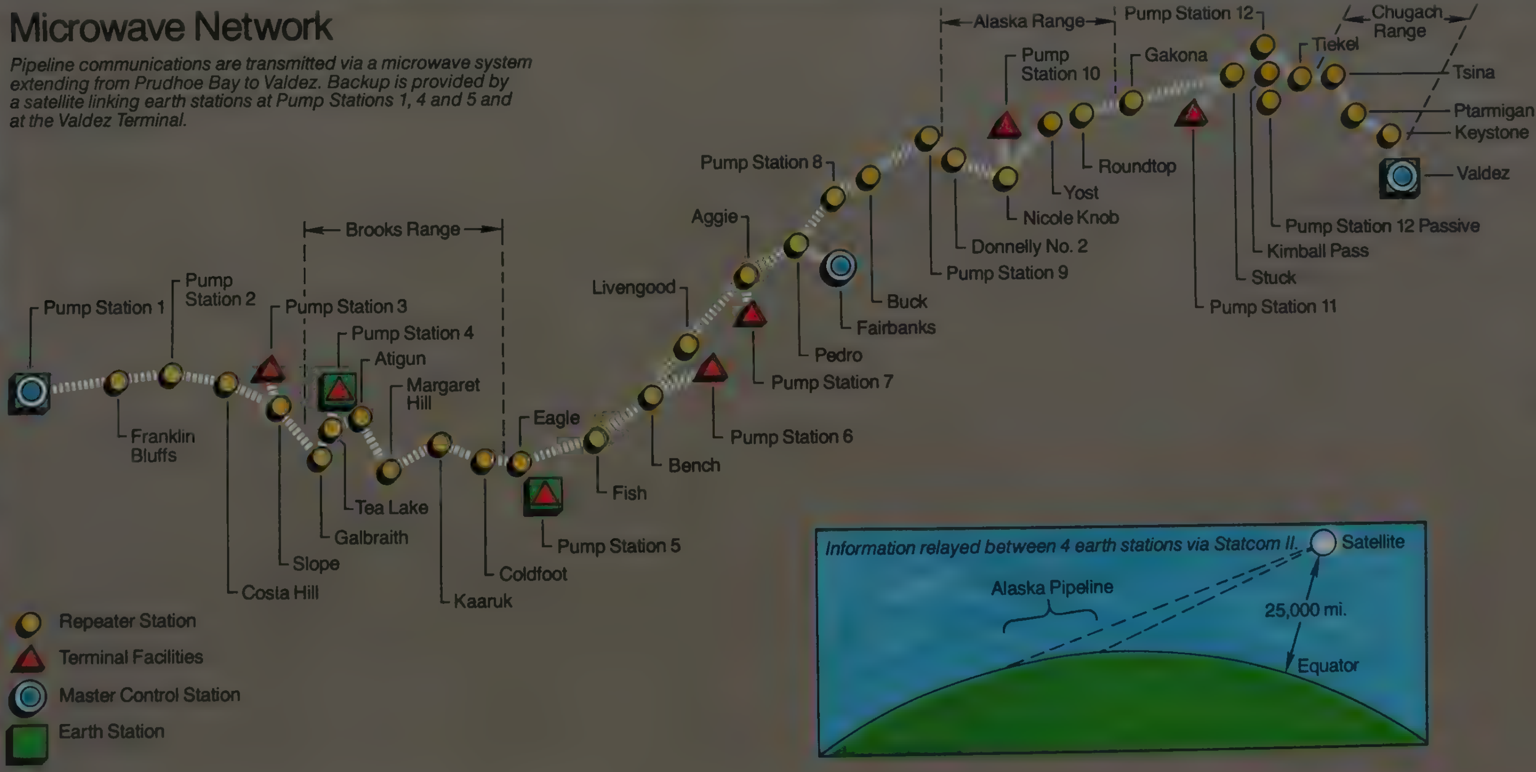
Data includes specific information on alarm conditions, the leak detection system, flow rates, pressures, temperatures, specific gravities and the operating status of pumps, valves and other equipment. The information, analyzed and stored by computers, is displayed on

---

Backbone of the pipeline's communications networks is a microwave system.

Microwave Network

Pipeline communications are transmitted via a microwave system extending from Prudhoe Bay to Valdez. Backup is provided by a satellite linking earth stations at Pump Stations 1, 4 and 5 and at the Valdez Terminal.



television-like cathode ray tubes in summary formats for quick review by the Pipeline Controller.

All of the information is transmitted over the pipeline's backbone communications system of microwave stations which generally parallel the pipeline route and which link pump stations and maintenance centers with Valdez. Remote valves on the pipeline are linked by dual VHF radio channels to the main network.

The microwave system is backed up by a satellite communications system. Earth stations at Pump Stations 1, 4, 5 and at Valdez can communicate with each other via a space satellite in orbit 25,000 miles above the equator. The satellite system handles all pipeline control data in event of any break in communications in the chain of microwave stations.

Response Systems

Information transmitted by the systems can trigger a variety of responses. In some instances, signals to the operations center can initiate automatic reactions. In most cases, however, the Pipeline Controller initiates any response.

Pressure changes, communications failures, valve closures, seismic alarms, relief-tank-level signals — all can trigger preprogrammed, automatic responses ranging from shutting down an individual station to shutting down the entire system.

A high-level earthquake alarm, for example, will initiate an automatic sequence of events which will shut down the line in five minutes unless the alarm is acknowledged at the Operations Control Center.

In another instance, if the oil levels in the relief tank at Pump Station 5, on the downstream side of the Brooks Range, exceed established limits, the automatic system blocks the line into the station and then shuts down the upstream Pump Station 4.

The control system also is set up to handle a large number of situations on a sequential basis. After the Pipeline Controller initiates a sequence, the Control Center computer orders the series of events required to execute the command.

For instance, once the Controller initiates a "station shutdown" command for any pump station, main pumps in the station are shut down and locked out in sequence; booster and injection pumps are shut down if in operation; automatic scraper bypass controls are switched to manual mode and, if the order is directed to Pump Station 1, incoming oil is switched to storage tanks and tank outlet valves are closed.

To isolate a pump-house, while permitting oil to bypass a station, the sequential system shuts down main, booster and injection pumps; switches scraper operation to a manual mode; cuts off fuel and gas valves, and opens valves to permit mainline oil to bypass the pumps.

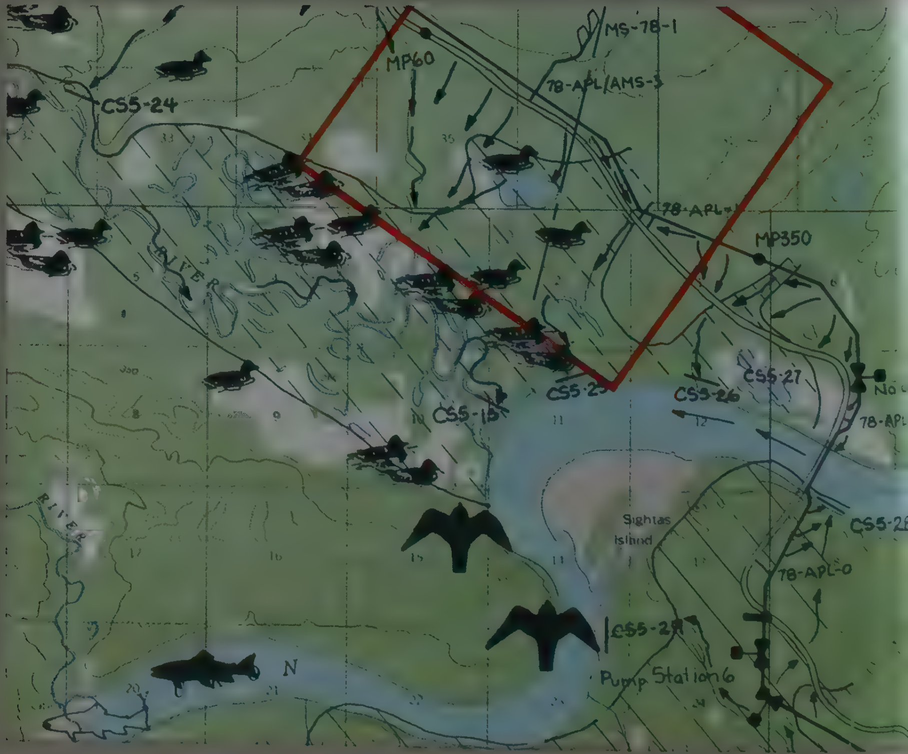
Controllers also can issue a number of specific commands to particular pieces of equipment. Booster and injection pumps at stations can be started and stopped individually. Gate valves, ranging from those controlling the flow of oil from producers to remote valves along the line, can be opened and closed on command.

In addition, detailed

Status of all valves and direct control over 62 gate valves is maintained by the Pipeline Controller.

Contingency Plan

A map (right) and aerial photo (far right) taken from the Alyeska Oil Spill Contingency Plan show the myriad of vital details collected on one small pipeline section just north of the Yukon River. In addition to damage features, the map and photo identify high priority wildlife zones, valve locations, containment points and sensitive soil areas. Aerial photo area is outlined with orange on map.



procedures have been established for Controllers in some of the more complex operation and emergency situations. Steps for starting the system, normal shutdowns, varying flow rates, changing pumps, operating remote gate valves, moving scraper pigs through the system and dealing with seismic events all are spelled out in detail for the Pipeline Controller.

Leak Detection

Four automatic leak detection and alarm systems are provided for the Controllers: pressure deviation, flow rate deviation, flow rate balance deviation and line volume imbalance. All leak detection alarms are processed by the Control Center computer.

The pressure deviation method can indicate large leaks near a pump station site. The alarm will sound if measured pressure at a site drops from the pre-set value.

Much more sensitive is the line volume imbalance method. Oil entering the line, oil arriving at the Terminal and any oil off-takes are measured by sensitive meters whose accuracy is proved regularly. These readings are calculated by computer, with compensations for pressure, temperature, viscosity and other variables, to achieve precise balancing.

The flow rate deviation and flow rate balance deviation systems depend upon Leading Edge Flow Meters, or LEFMs, which are the latest result of years of research by the metering industry for measurement of fluid flows using sonic signals.

The LEFMs are installed on the discharge side only at Pump Station 1, and on the suction and discharge sides at the 11 other sites. Flow rate deviation trips an alarm if the flow rate measured deviates from the pre-set value. The flow rate balance deviation system detects differences from the pre-set value of the flow rate between adjacent stations.

All the pre-set values are deduced from operating conditions measured a fixed time before.

The automatic leak detection systems are supported by frequent visual air and ground surveillance.

Leak Procedures

If a leak is detected and located, the Pipeline Controller immediately will alert Alyeska teams responsible for controlling and cleaning up any spills.

While one team stops or limits the leak, another task force handles logistics, manpower, communications and documentation problems. Government agencies are also notified.

Crews at any spill scene are armed with detailed information on what to do. Every mile of the line has been analyzed with a possible spill in mind so that crews can identify sensitive wildlife and fish habitats and can know precisely where to erect any needed containment structures.

Terminal Controller

The Terminal Controller maintains the same high level of control over Terminal operations that Pipeline Controllers maintain over the pipeline. The Terminal computer presents the Controller with constantly updated information on all phases of Terminal operation. Included are data on storage tank levels; valve status; incoming oil flow; berthing

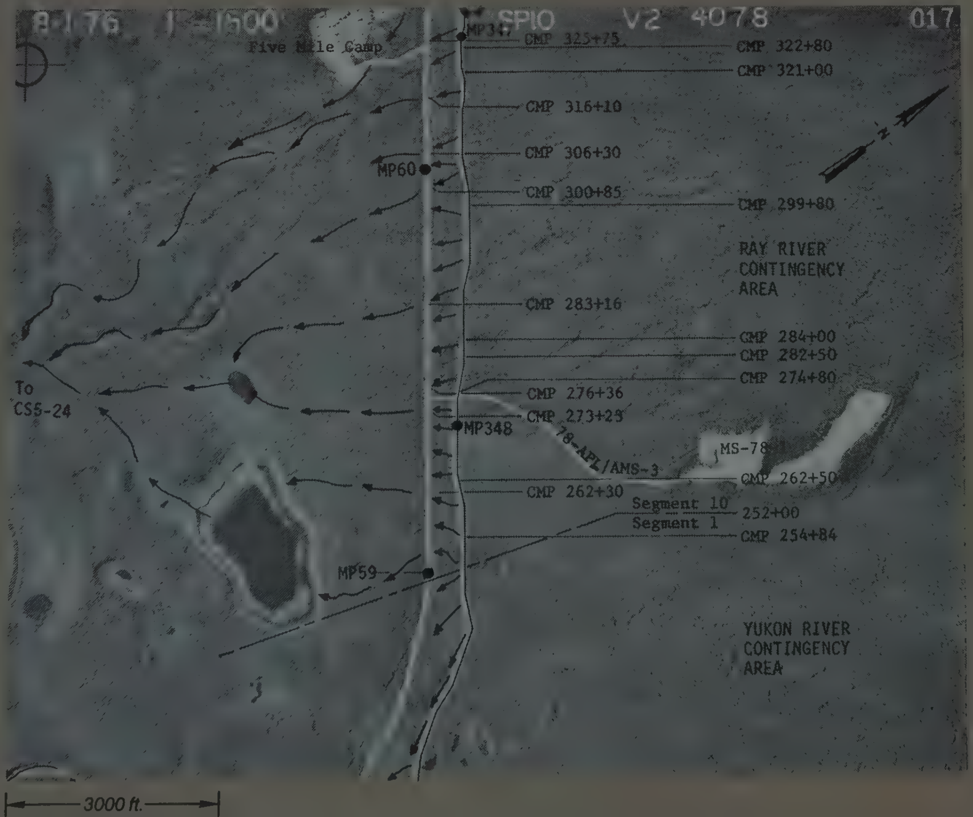
lanation for map at left

Above-ground pipe
Below-ground pipe
Access roads (operations)
Material sites (operations)
Remote valves (number)
Block points on work pad
Containment sites
Oil drainage patterns
Haul road (north of Yukon River)
Contingency areas
Mile posts (pipeline and road)

Areas sensitive to surface disturbance during thawed or frozen conditions.

Areas sensitive to surface disturbance during thawed conditions.

The highest priority environmental zones along the pipeline corridor.
Waterfowl nesting, rearing, and staging
Fish spawning (fall) and overwintering
Fish spawning (spring) and rearing
Raptor nesting



Explanation for aerial photo

—	*Pipeline – above-ground*
-----	*Pipeline – below-ground*
	Check valve
⋈	*Manual valve*
	Remote valve
	Oil drainage pattern
	Contingency area
● MP	*Milepost (pipeline)*
● MP	*Milepost (road)*
CS	*Containment site*
▬	*Block point (no access)*
APL	*Access to pipeline*
AMS	*Access to material site*
APS	*Access to pump station*
LWC	*Low water crossing*
CMP	*Culvert*
BR	*Bridge*
MS	*Material site*

information, and operations of the vapor recovery system, power plant and ballast treatment plant. In addition, Controllers receive information on oil flow into storage tanks and from tanks to the Terminal's four loading berths, on oil flow from Pump Station 1, on seismic conditions and on marine and weather conditions. A special fire protection display on the Controller's console notifies him of fire alarms anywhere in the Terminal area.

The Controller also commands the Terminal's metering system, and makes certain that meters have been proved for accuracy by the Terminal prover system and that records are complete.

Information received by the Terminal Controller can trigger a variety of responses. In some instances, automatic sequences are begun. In others, the Controller may be signaled to start particular procedures.

In case of a failure of the vapor recovery system to maintain the proper levels of positive pressure in any storage tanks, for instance, an alarm sounds. Unless the Controller responds to the signal within 10 seconds, valves are opened or closed, as necessary, to maintain the proper pressures of inert gas in the tank and to prevent the flow of any air into the tanks.

Terminal Response Systems

Step-by-step responses are spelled out for the Terminal Controller in other operating or emergency situations. During tanker loading, the Controller monitors the loading rate of oil and oil levels in discharging tanks. At the end of a loading sequence, he closes down all valves in the delivery system.

The Controller also controls valves during the transfer of oil from one tank to another, sets up the flow of ballast water from tankers to the Terminal treatment plant and monitors the flow of ballast until the discharge cycle is complete. In addition, the Terminal Controller aligns valves for the movement of pipeline scrapers into the Terminal.

In the unlikely case of an oil spill within the Terminal, the Controller takes immediate steps to limit the spill and then initiates containment efforts by alerting the Alyeska oil spill coordinator and other officials.

The Controller is charged, too, with initiating responses to any tanker spills in Prince William Sound. The oil spill coordinator and Terminal superintendent and Controller then would activate Alyeska response teams and clean-up crews.

Although Pipeline and Terminal Controllers command almost every phase of the pipeline operations, some parts of the system can be controlled locally, generally with permission of system Controllers.

Localized Controls

Pump station operators can operate local valves, booster pumps, injection pumps and tank mixers. They can monitor local operating conditions from appropriate gauges, check the status of pump station equipment and adjust the limits of station operation. Pump station operators are alerted by a system of audible alarms and warning lights to all local emergency situations.

Each station is equipped with a number of automatic protective

Pipeline and Terminal Controllers initiate actions at every operating level.

Containment booms are deployed in berth areas.

Skimmer boats are the workhorses of a containment process. See right.

devices which can shut down a piece of equipment or the entire station. Some will isolate the station from the mainline and others will shut down the mainline. Included are fire sensing devices on all equipment; heat sensors on pumps and drivers; liquid-level detectors on tanks and pumps; pressure sensors in pipes; atmosphere sensing devices in all enclosed buildings; turbine speed indicators; vibration detectors; reverse rotation monitors, and flow rate sensors.

In the Terminal, tanker loading operations at the four berths are under the local control of the Terminal marine superintendent.

The superintendent and his staff control all deballasting and oil loading operations at the berths. As in other pipeline operations, procedures are spelled out in detail. In preparation for the arrival of a tanker, berth operators are required to go through a detailed readiness check on oil loading arms to make certain the arms will function properly in all positions. They are required to check out alarm systems on the loading arms, firefighting equipment and mooring hook releases before a tanker arrives.

In receiving ballast from a tanker, the Terminal Controller sets up pipe-routing for delivery of the ballast to the treatment plant, but then grants permission to the berth officials to handle actual discharges from berthed tankers. Operators are charged with detecting any possible spills during the pumping operation.

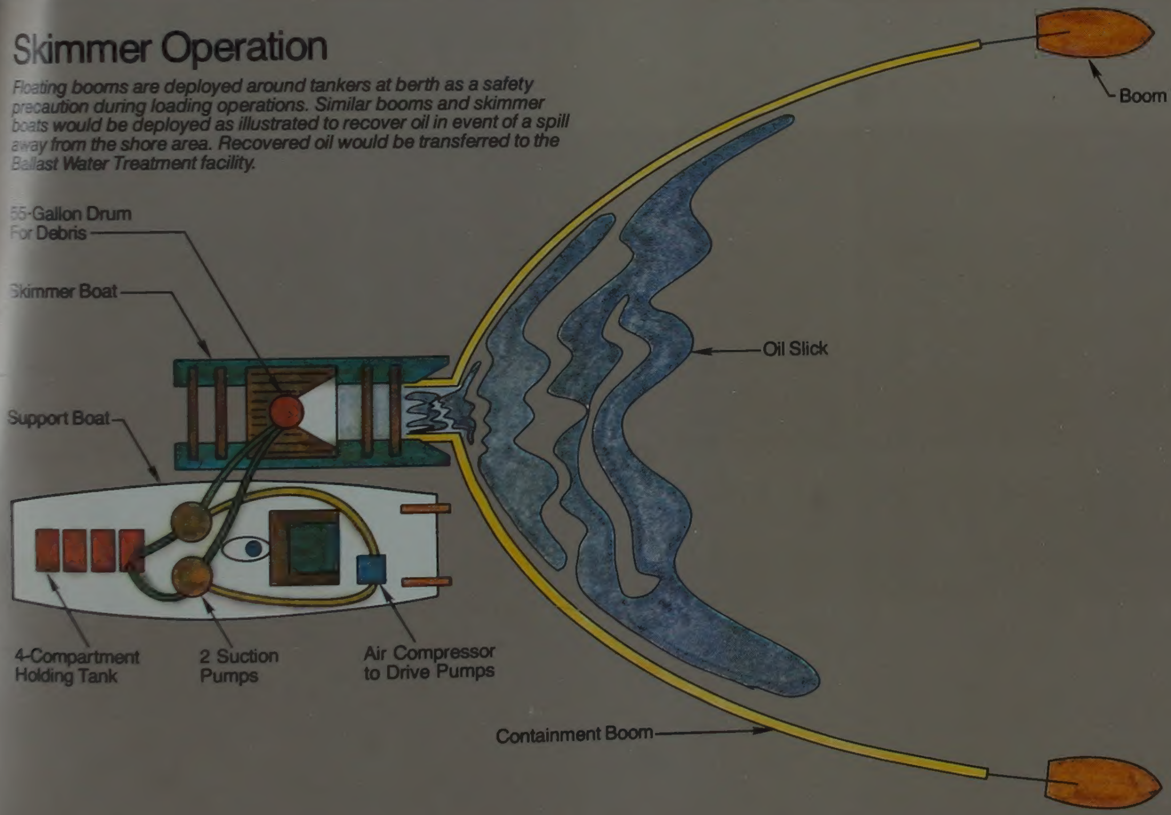
Similar procedures are set out for oil loading. When given permission by the Terminal Controller, berth operators can open berth valves to start delivery of crude oil to the tankers. Interlocks in valve systems block the flow of crude oil when ballast water valves are open or when any fire or danger signals have been activated.

The marine supervisor is responsible for inspecting tankers before loading begins and, also, for reviewing loading procedures and restrictions with tanker officers.

Terminal crews are to provide containment and cleanup assistance to tankers in event of any spill at the Terminal. In event of a spill near a tanker, floating booms would be deployed around the vessel and surface oil. Skimmer boats then would recover oil within the booms and transfer it to barges or other facilities. Near shoreline, booms would be deployed to protect threatened areas. Contaminated water collected in the process would be discharged into the Terminal ballast treatment system.

Skimmer Operation

Floating booms are deployed around tankers at berth as a safety precaution during loading operations. Similar booms and skimmer boats would be deployed as illustrated to recover oil in event of a spill away from the shore area. Recovered oil would be transferred to the Ballast Water Treatment facility.


Boom Tow Boat
55-Gallon Drum For Debris
Skimmer Boat
Oil Slick
Support Boat
4-Compartment Holding Tank
2 Suction Pumps
Air Compressor to Drive Pumps
Containment Boom

Tow boats extend containment booms out from a skimmer boat.

History/Future

A century ago, ground seepages gave evidence of oil on the North Slope. However, it wasn't until July 1968 that confirmation of the Prudhoe Bay field was made by Atlantic Richfield Company and Humble Oil and Refining Company (now Exxon U.S.A.). Within a year, plans for a pipeline were announced. Initiated then were five years of study and testing. Among the principal subjects examined by scientists and engineers were terrain, climatological factors, equipment systems, materials, resource and environmental risk values and revegetation. Archeologists also surveyed the entire pipeline route.

Early in 1970, several suits to halt pipeline construction were filed in courts by environmental groups and others. A 3½-year-long series of legal and legislative proceedings followed, during which no construction was allowed.

Also, in 1970, all responsibilities for design, construction, operation and maintenance of the pipeline were assumed by the newly formed Alyeska Pipeline Service Company. The agent company was established by seven petroleum companies, and now is owned by eight firms.

Alyeska received permission to begin construction through Presidential approval of pipeline legislation on November 16, 1973.

A massive logistical program began immediately. First of the visible achievements was putting equipment, supplies and construction camps in place north of the Yukon River during the winter of 1973-74.

Road Built — 1974 — An enormous effort was required to build the 360-mile road from the Yukon to Prudhoe Bay. Construction began April 29, 1974. One hundred fifty-four days later, the completed roadbed and its initial gravel overlay were in place. During the same period, development also began on the pump stations, marine terminal and pipeline work pad.

First Pipe Laid — 1975 — The first mainline pipe to be installed was lowered into the Tonsina River north of Valdez March 27, 1975. And, by the close of the year, 368 miles of the 800-mile pipeline had been installed along the route. Terminal and pump station construction passed the one-quarter-completion point and the State of Alaska's Yukon River bridge entered service. The new 2,290-foot span ended the use of barges, hovercraft and winter ice bridges in crossing Alaska's mightiest river.

Employment along the line reached its peak of 21,600 in August, a level nearly duplicated the following year. Thirty-one construction camps, strung from Pump Station 1 on the North Slope to the Valdez Terminal, housed the workers.

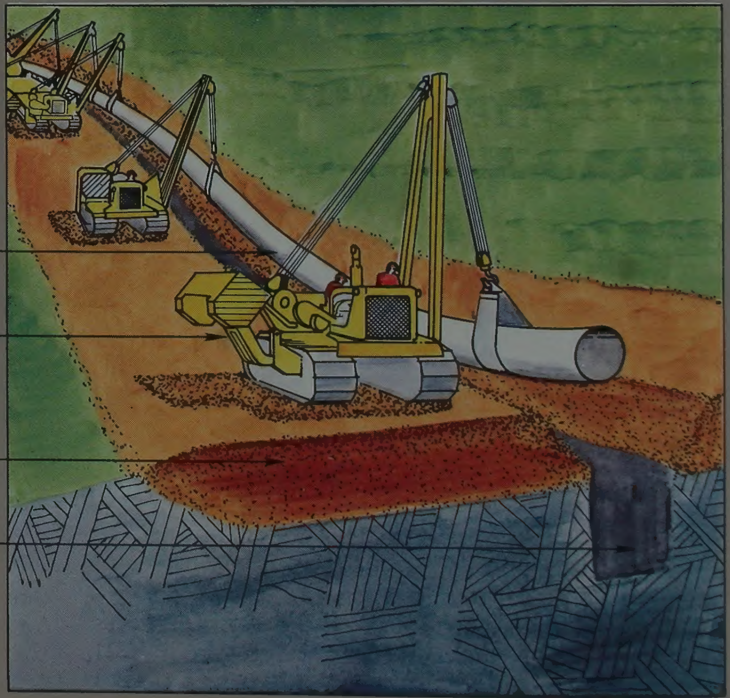
92 Per Cent Completed — 1976 — Total construction on the overall project, including pipeline, pump stations and Terminal, rose from 41 to 92 per cent completed during 1976. During the year, 428 miles of buried and above-ground pipe were installed. Those miles included three of the major pipelaying challenges: Atigun Pass in the Brooks Range, the line's high point; precipitous Thompson Pass, and Keystone Canyon in the Chugach Mountains near Valdez.

A massive logistical effort culminated in the start of road construction April 29, 1974.

An early road link-up occurred in mid-1974 on the North Slope tundra.

Placing Below Ground Pipe

A conventional pipelaying method used worldwide was employed to place below-ground pipe. Normally, several sections of pipe, called joints, were welded together. Sideboom tractors worked in unison to lower the length of pipe into position atop specially prepared bedding material. Burial followed.



Considerable effort also was expended during the year to confirm the integrity of questionable welds discovered in 1975 by the Alyeska Quality Assurance department. More than 99 per cent of the weld and/or radiographic inconsistencies discovered in a special audit were remedied by year's end. Pump stations reached a 91 per cent completion level in 1976 and the Valdez Terminal advanced to 83 per cent, which accounted for most facilities needed for pipeline startup.

Installation of pipeline bridges, progress on the 147-mile natural gas pipeline to provide fuel for the northern four pump stations, hydrostatic testing of the oil pipeline, and testing of many system components all were among 1976's other significant accomplishments.

By year's end, 13 construction camps had been closed and the work force had been reduced to 4,500, with a 1977 high of 7,000 expected a few months later.

Operation Started — 1977 — By May of the start-up year, all 800 miles of pipeline had been installed and hydrostatically tested; and essential pump station, terminal and communications system work was nearing completion. Simultaneously, during this period, and in earlier construction years, planning and training for pipeline operation progressed at an increasing tempo, culminating in start-up of the line June 20, 1977.

Passage of the first oil from Pump Station 1 to the Valdez Terminal was completed July 28. The first tanker-load of oil was shipped August 1 aboard the S.S. Arco Juneau.

Start-up was marred by a tragic explosion at Pump Station 8 which destroyed the main pump building and killed one technician who was responding to fight the fire which followed. As a result, Pump Station 9 was brought on line earlier than originally planned, and the pipeline's 1.16 million barrel-per-day operating schedule was postponed until 1978 when Station 8 repairs could be completed.

Several achievements behind the scenes during planning and construction were equally as important as the on-line work itself:

Logistical operations for pipeline, pump stations and Terminal construction accounted for the purchase and movement of 3.5 million tons of supplies, material, equipment and machinery, the equivalent of 180,000 truckloads.

The presence of permafrost underlying most of the pipeline route made innovative techniques and designs necessary. This included the above-ground pipeline itself and its heat pipes and thermal insulation; elevated gravel workpads, and extensive use of polystyrene board for ground insulation.

Some time in the early 21st century, the last Prudhoe Bay oil is expected to pass through the pipeline. Exactly when the flow ends will depend on the eventual size of recoverable reserves and upon the rate at which the line is run. Beyond then, the system may be dismantled or may be used for other possible northern Alaska oil reserves.

First mainline pipe was installed March 27, 1975, in the Tonsina River.

Thompson Pass's difficult terrain was surmounted in 1976.

Oil entered the pipeline June 20, 1977. News media members recorded preparations for the start-up the preceding day.

The first tanker-load of oil headed for a Lower 48 refinery August 1, 1977.

University of Alberta Library
0 1620 0335 2620

Alyeska pipeline
SERVICE COMPANY

1835 South Bragaw Street
Anchorage, AK 99512